Volume 22, Number 17, September 15, 1968

NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Division of Technical Information, Edward J. Brunenkant, Director, Published by the USAEC Divison of Technical Information Extension, Robert L. Shannon, Extension Manager.

Nuclear Science Abstracts provides the only comprehensive abstracting and indexing coverage of the international literature on nuclear science and technology. *NSA* covers scientific and technical reports of the U. S. Atomic Energy Commission and its contractors, those of other U. S. Government agencies, and those of other governments, universities, industrial, and research organizations. It also covers patents, books, and journal literature on a worldwide basis.

Scanning, selecting, and abstracting the literature in Canada, Denmark, Finland, Japan, Norway, Sweden, and the United Kingdom are carried out by the following organizations:

Atomic Energy of Canada Limited
Danish Atomic Energy Commission
Finnish Atomic Energy Commission
Japan Atomic Energy Bureau–Atomic Energy Research Institute
Institutt for Atomenergi (Norway)
Aktiebolaget Atomenergi (Sweden)
United Kingdom Atomic Energy Authority

Through special cooperation of the Netherlands Patent Office and the Institut International des Brevets, abstracts of European patents are provided. Numerous organizations, societies, and publishers throughout the world provide advance page-proof copy of their journals and publications. In the United States page-proof copy of the publications of the American Institute of Physics is provided.

A list of the journals regularly scanned appears in Issue Number 1. This list is supplemented in each odd-numbered issue. Nearly 450,000 abstracts have appeared in *NSA* through Volume 21. The subject matter covered in *NSA* is described in Issue 1 of each volume and in TID-4552, *Subject Scope of Nuclear Science Abstracts.* The latter is available free from the U. S. Atomic Energy Commission, Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37830.

Abstracts are arranged according to subject categories which are defined in Issue 1 of each volume. If the language of the original item is not English, the language is indicated.

AVAILABILITY OF PUBLICATIONS ABSTRACTED

The public availability of all U. S. Atomic Energy Commission reports is indicated in the report number indexes. The availability of other reports, when known, is also indicated. The availability of some unnumbered reports is given in the abstract.

Dissertations abstracted in *Dissertation Abstracts* and included in *NSA* are available from University Microfilms, Inc., 315 N. First Street, Ann Arbor, Michigan 48103.

Information on the availability of the published literature and unpublished conference papers abstracted in *NSA* may be obtained from the Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37830. In addition to the CFSTI availability cited in the report number index, AEC translations are also on deposit at the Special Libraries Association Translation Center, John Crerar Library, Chicago, Illinois.

HOW TO OBTAIN NUCLEAR SCIENCE ABSTRACTS

NSA is available to the general public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402, as follows:

For the 24 regular issues, $30.00 domestic, $37.00 foreign. A single issue costs $1.75, plus 25 percent for foreign mailing. Domestic rates apply to the United States, Canada, Mexico, and Central and South American countries except Argentina, Brazil, Guyana, French Guiana, Surinam, and British Honduras. Foreign rates apply to the countries excepted above and to all other countries throughout the world.

For the quarterly, semiannual, and annual indexes, $22.00 domestic, $25.00 foreign.

Multivolume indexes are available as follows:

From Johnson Reprint Corporation, 111 Fifth Avenue, New York, N. Y. 10003

Vols. 1–4, Subjects and Authors (1948–1950). $30.00

From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402

Vols. 5–10, Subjects and Authors (1951–1956). $5.25
Vols. 11–15, Subjects (1957–1961). $19.00
Vols. 11–15, Personal Authors (1957–1961). $14.25
Vols. 11–15, Corporate Authors (1957–1961). $2.50
Vols. 16–20, Subjects (1962–1966). $36.00
Vols. 16–20, Personal Authors (1962–1966). $22.50
Vols. 16–20, Corporate Authors (1962–1966). $3.75
Cumulative Report Number Index, Vols. 1–15 Revised. $4.00
Vol. 21, Subjects and Authors (1967). $16.00
Cumulative Report Number Index, Vols. 16–21. $4.25

NSA is available on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information. Inquiries should be directed to the U. S. Atomic Energy Commission, Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37830.

Government agencies may obtain *NSA* free of charge.

INDEXES TO NSA

Comprehensive indexes appear in each issue and are cumulated quarterly, semiannually, and annually. Multivolume cumulations have been issued as indicated above.

All documents abstracted are indexed by subjects and personal authors. Technical report literature is indexed also by corporate author and report number. Each of these indexes in every issue is preceded by an introduction explaining in detail the organization of the index and the principles by which it is compiled. The reader is referred to these explanations for information not found in the brief summary below.

Index References

All index entries refer the reader to volume and abstract number:

```
FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
```

Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

```
MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
```

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

```
SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
  radiosensitivity of hematopoietic system of, x,
    21:8905(R) (AD-631189)
```

```
SHELTERS
  construction of, for civil defense,  21:8838
  design of fallout,  21:8777(R) (AD-629736)
  design of shaft closure for,  21:8563(P)
  determination of configuration of, for ventilation,
    21:8779(R) (AD-629928)
  equipment for fallout, minimal requirements of,
    21:8782(R) (AD-631424)
  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
```

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

```
UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
```

Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

```
TID-
  3311(Suppl.  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
    2)
  22298        21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                           1966)
  22298        21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                           1967)
  23267        21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                           1966)
  23287        21-8498   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23420        21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474        21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23478        21-8641   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23482        21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
```

TABLE OF CONTENTS

Volume 22, Number 17, September 15, 1968

Category	Page
CHEMISTRY	3635
Analytical Chemistry	3635
Inorganic, Organic, and Physical Chemistry	3637
Radiation and Nuclear Chemistry	3644
Radiochemistry	3650
Separation Processes	3650
EARTH SCIENCES	3655
Geology and Hydrology	3655
Meteorology	3657
Mineralogy and Exploration	3658
Oceanography	3659
Seismology	3659
ENGINEERING	3660
Nuclear Explosions	3660
Facilities and Equipment	3661
Heat Transfer and Fluid Flow	3663
Isotope Technology	3664
Materials Testing	3665
Protective Structures	3665
Radioactive Material Handling	3666
INSTRUMENTATION	3667
Radiation Detection Instruments	3667
General Detectors and Monitors	3667
Nuclear Spectroscopic Instrumentation	3671
High Energy Physics Instrumentation	3672
Radiation Dosimeters	3673
Radiometric Instruments	3674
Miscellaneous Instruments and Components	3674
Radiation Effects on Instruments and Instrument Components	3677
LIFE SCIENCES	3679
Biochemistry, Physiology, and Molecular Biology	3679
Ecology	3687
Genetics and Cytogenetics	3687
Health Physics and Safety	3689
Medicine	3694
Radiation Effects on Animals	3699
Radiation Effects on Plants	3707
Radiation Effects on Microorganisms	3707
Radiosterilization and Radiopreservation	3709
METALS, CERAMICS, AND OTHER MATERIALS	3710
Metals and Alloys	3710
Corrosion and Erosion	3710
Preparation and Fabrication	3711
Properties Evaluations	3712
Structure and Phase Studies	3716
Radiation Effects	3718
Ceramics and Cermets	3720
Corrosion and Erosion	3720
Preparation and Fabrication	3720
Properties Evaluations	3721
Structure and Phase Studies	3722
Radiation Effects	3723
Plastics and Other Materials	3723
PHYSICS (GENERAL)	3724
Astrophysics and Cosmology	3724
Atomic and Molecular Physics	3736
Cosmic Radiation	3742
Direct Energy Conversion	3744
Fluid Physics	3745
Geophysics	3746
PHYSICS (GENERAL) *cont'd.*	
Low-Temperature Physics	3753
Plasma and Thermonuclear Physics	3755
Confinement and Heating of Plasma	3755
Diagnostics of Plasma	3756
Kinetics of Plasma	3758
Production of Plasma	3763
Stability of Plasma	3763
Thermonuclear Processes	3764
Shielding	3764
Solid-State Physics	3765
Theoretical Physics	3774
PHYSICS (HIGH ENERGY)	3776
Particle Interactions and Properties (Experimental)	3776
Electromagnetic	3776
Weak	3776
Strong (Baryon-Induced)	3776
Strong (Meson-Induced)	3777
Particle Interactions and Properties (Theoretical)	3778
General	3778
Electromagnetic	3778
Weak	3780
Strong (General)	3781
Strong (Baryon No. = 0)	3781
Strong (Baryon No. = 1)	3783
Strong (Baryon No. ≥ 2)	3784
Particle Invariance Principles and Symmetries	3785
General	3785
Applications (Electromagnetic and Weak)	3786
Applications (Strong)	3786
Field Theories	3787
General	3787
Quantum Field Theory	3787
Gravitation and General Relativity	3787
Scattering Theory	3788
Particle Accelerators	3789
PHYSICS (NUCLEAR)	3796
Neutron Interactions with Matter	3796
Nuclear Properties and Reactions, $A \leq 5$	3797
Nuclear Properties and Reactions, $6 \leq A \leq 19$	3797
Nuclear Properties and Reactions, $20 \leq A \leq 89$	3799
Nuclear Properties and Reactions, $A \geq 90$	3802
Nuclear Theory	3806
REACTOR TECHNOLOGY	3809
Central Power Reactors	3809
Marine and Portable Power Reactors	3817
Rocket and Space Reactors	3818
Process Heat and Desalination Reactors	3819
Research and Test Reactors and Critical Assemblies	3820
Production Reactors	3822
Reactor Theory, Components, Fuels, and Accessories	3822
GENERAL	3829
CORPORATE AUTHOR INDEX	INDEX-1
PERSONAL AUTHOR INDEX	INDEX-8
SUBJECT INDEX	INDEX-59
REPORT NUMBER INDEX	INDEX-147
JOURNAL LIST	APPENDIX-1

STAFF OF NUCLEAR SCIENCE ABSTRACTS

John W. Norris
Managing Editor

Donald D. Davis
Assistant Managing Editor

David E. Bost
Production Manager

Sidney F. Lanier
Subject Heading Specialist

J. Paul Meredith
Descriptive Cataloging Specialist

Frederick E. Marsh, Jr.
Computer Index Coordinator

Clara L. Fox
Corporate Author Specialist

Helen W. White
Report Number Specialist

Section Editors

Everett J. Hoffman
Chemistry

Robert C. Kelly
Engineering; Earth Sciences; Metals and Ceramics

Lee M. Thompson
General Physics

Charles E. Stuber
High Energy Physics; Instruments

Helen G. Donald
Life Sciences

Lawrence T. Whitehead
Nuclear Data

James M. Jacobs
Reactor Technology

Evaluators

Thomas S. Chapman
Rose V. Jermain
John H. Mitchell
Mary H. Newman
Polly C. Summers

Abstractors

F. S. Armstrong*
Ellis R. Bedford
Mary M. Brown
Ann W. Bryan
Jane G. Buchanan
D. Lamar Cason
Perry G. Cotter
David C. Cunningham
Bennie G. Di Bona
James R. Dulaney
Mary C. Grissom
Phyllis C. Hansen
Carolyn D. Houston
Rose V. Jermain
W. Hugh Kinser, Jr.
Billie S. Lane
Lisbeth C. Lieberman
Betty L. McDowell
Fay M. Martin
William D. Matheny
Dora H. Moneyhun
Carol Oen
Jean F. Peckham
Henry D. Raleigh
Mona H. Raridon
Julia S. Redford
Francis L. Sachs
Lila B. Smith
Myrna L. Steele
J. J. ten Bosch
Anne G. Ward
Helen L. Ward
David C. West
Milton O. Whitson
Juanita Wilson

*Atomic Energy of Canada, Ltd.

Communication concerning the editorial policy and content of *NSA* should be addressed to the Managing Editor, *Nuclear Science Abstracts*, AEC Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37830.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget, June 28, 1966.

Volume 22, Number 17 September 15, 1968

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 35828, 35928, and 36522.

35748 IMPURITY DETECTION PROCESS AND APPARATUS. Fragneau, Guy (to Commissariat a l'Energie Atomique). British Patent 1,116,482. June 6, 1968. Priority date Mar. 5, 1965, France.

A method and apparatus are described for detecting the presence of UF_6 in a gas. The apparatus consists of a tube with a gas inlet at one end and an outlet at the other end. A number of superposed transparent plates to receive a liquid that changes color in the presence of UF_6 and having staggered apertures to allow the gas to flow are positioned along the length of the tube. A system for producing a parallel light beam and for measuring the intensity of the luminous flux after it has passed through all the plates is included. Oils that change color under the action of UF_6 and that are suitable for use in the plates are Sogev oil AD and Apiezon C. (B.L.M.)

35749 TERRESTRIAL MODIFICATION OF TRACE ELEMENTS IN IRON METEORITES. Berkey, Edgar. Ithaca, N. Y., Cornell Univ., 1967. 131p.

Thesis.

Iron meteorites were studied in a combined program of neutron activation analysis, spark-source mass spectrometry, and metallography to investigate possible changes in their trace element composition produced by terrestrial residence. It was experimentally established for the first time that terrestrially induced processes can profoundly affect the trace composition, adding large amounts of some elements to the matrix, while at the same time removing others from it. A study of the Cl content of iron meteorites by activation analysis revealed that the element can be enhanced in finds by many orders of magnitude over certain localized regions. The source of this enhancement appears to be the Cl^- normally present in ground water coupled with electrochemical corrosion proceeding in such a way that Cl^- is rendered unleachable. Pathways used in the contamination process are cleavages, grain boundaries, Neumann lines, and even direct passage through the metal matrix. Measurements of primordial (nonterrestrial) Cl in the meteorites show that it is inhomogeneously distributed in the metal phase. The element is strongly depleted in kamacite and tends to concentrate at grain boundaries and around inclusions. The equilibrium solubility of Cl in relatively pure kamacite is much less than 1 ppM. Because of its inhomogeneity, it is difficult to calculate a representative average for the primordial Cl content of irons, but indications are that a good value is much lower than previous data which were not sufficiently cognizant of contamination effects. For the medium octahedrite Ilafall, Norfork, an average value of about 1 ppM was found for its Cl content in a region containing normal amounts of kamacite, taenite, plessite, and rhabdite, but excluding any large inclusions. Smithonia iron meteorite was studied by spark-source mass spectrometry to obtain simultaneous information on the distribution of a large number of elements. The analyses were obtained by a systematic application of a milliprobe technique employing a 25-mil, high-purity Au wire as one electrode, with the sample as the other. The crater produced by each separate "probe" of the sample approximated 1.0 mm in diameter and 0.6 mm in depth. Substantial differences were found in the composition of the meteorite between the interior and exterior of the sample. Nineteen elements and many molecular species were detected near the surface at concentrations above a few ppM, while three less elements and only a few molecular species were detected at more interior points. The elements O, S, Cl, Br, I, and P were found to be significantly enhanced in the meteorite near the surface. The elements Na, K, and Ca gave indications of being depleted in the same regions. A consideration of the reasons for these effects focused on terrestrial weathering. Ground water appears capable of serving as the source of all the contaminants and also as the leaching agency by which some elements are removed. Electrochemical corrosion is fundamentally involved, although it was not possible to discern the precise reactions which render soluble components unleachable. The results obtained from the meteorite by the mass spectrometer were quantitated through the use of a certified low-alloy steel (NBS-461) to calculate experimental sensitivity factors. An independent investigation of Smithonia by neutron activation analysis verified the acceptability of using such a standard in the mass spectrometric analysis of iron meteorites. (Diss. Abstr.)

35750 DETERMINATION BY CHEMICAL ANALYSIS OF TRACES OF ^{7}Be, ^{32}P, ^{90}Sr, ^{210}Pb, AND ^{210}Po PRESENT IN THE AIR AND IN RAIN. Marenco, A.; Blanc, D.; Fontan, J.; Lacombe, J.-P.; Crozat, G. (Faculte des Sciences, Toulouse). Chim. Anal. (Paris), 50: 133-8 (Mar. 1968). (In French).

A study of long-lived radioactivity in aerosols, in the air, and in rain requires a method of chemical analysis. A method of separation of the isotopes ^{7}Be, ^{32}P, ^{90}Sr, ^{210}Pb, and ^{210}Po deposited on a filter is described: after solution Po is deposited on Ag in a reduction step, the reducing agent is destroyed, and column separation of Pb is carried out. Then P is precipitated as a phosphomolybdate. After base is added the precipitate remaining is extracted with NaOH, thus separating Be from Sr. A somewhat different scheme is used for isotopes in rainwater. Methods of purification are described. The minimum activities in air which can be measured by the technique are 0.6×10^{-16} Ci/m^3 for ^{210}Po, 0.7×10^{-16} Ci/m^3 for ^{210}Pb, 0.4×10^{-14} Ci/m^3 for ^{7}Be, 0.8×10^{-16} Ci/m^3 for ^{32}P and ^{90}Sr. The method has been in use for two years and is attractive because of its rapidity. (BBB)

35751 ANALYTICAL UTILIZATION OF HAFNIUM AND ZIRCONIUM BOROHYDRIDES. Walsh, Ronald Edward Jr. Corvallis, Oreg., Oregon State Univ., 1968. 138p.

Thesis.

The borohydrides are the most volatile known compounds of hafnium and zirconium and consequently have potential analytical utility. The determination of hafnium and zirconium in the presence of each other has long been a difficult assignment and there are a limited number of good analytical methods. The borohydrides are reviewed and a study made of their analytical utility. Apparatus has been devised to prepare and store the metal borohydrides. Conventional thermal electron bombardment mass spectrometry is not satisfactory for zirconium borohydride because of the compounds' thermal instability. Zr^+, ZrH^+, and various doubly charged species in the m/e 60-70 region have been found. Apparatus and methods were developed for the analytical hydrolysis of the metal borohydrides and their mixtures. Zirconium borohydride is quantitatively hydrolyzed ($99.97 \pm 0.14\%$) and hafnium borohydride incompletely hydrolyzed ($97.80 \pm 0.68\%$) to hydrogen gas in aqueous 3 N hydrochloric acid. The formation of diborane observed in the incomplete hydrolysis of pure hafnium and zirconium borohydrides is indicative of at least a two step hydrolysis reaction: first a fast step producing diborane and hydrogen; secondly a slow hydrolysis of diborane. The hydrolysis method

is applied to the analysis of hafnium/hafnium + zirconium ratios (× 100) in the range 1 to 11% with an accuracy of ±0.2%. (Disser. Abstr.)

35752 ATOMIC ABSORPTION DETERMINATION OF STRONTIUM. Intonti, R.; Stacchini, A. (Istituto Superiore di Sanita, Rome). Spectrochim. Acta, Part B, 23: 437-42(June 1968).

The determination of strontium by atomic absorption spectroscopy using air–propane and air–acetylene flames is described. The influence of flame temperature on extinction coefficients, detection limits, and reproducibility of measurements is discussed. The effects of alkali and alkaline earth metals on the absorbance of strontium in both flames were investigated. The effects varied according to the concentration of the interfering metal, the concentration of the element and the experimental conditions (flame, flame temperature, atomization). The sensitivity can be increased by using a hotter flame (air–acetylene) or by adding small quantities of cesium or potassium. A modulated double beam spectrophotometer with a digital readout system was used. (auth) (UK)

35753 A SPECTRAL ANALYSIS METHOD FOR THE DETECTION OF CALCIUM AND MAGNESIUM IN TANTALUM. Herbst, K.-H. (Univ. of Goettingen, Ger.). Spectrochim. Acta, Part B, 23: 489-93(June 1968). (In German).

A method for the detection of impurities in Ta powder was developed, which makes use of upper and lower "stuffed" electrodes excited in a spark discharge. By the action of the spark the content of the upper electrode is gradually dropped into the discharge. Detection limits of 3 ppm for Ca and 10 ppm for Mg were obtained. The reproducibility is in the order of 20%. In order to depress the interfering CN-bands a ratio as high as 1:2 carbon powder to sample material is advisable. The proposed method appears promising in all cases where the normal dc arc cannot be used, because of its high inherent background due to band spectra. For obtaining reliable results the "stuffing" pressure for charging the electrodes should be well controlled, and for this purpose a suitable tool was devised, particulars of which are given. (auth) (UK)

35754 THE POLAROGRAPHIC DETERMINATION OF THE O/U RATIO IN URANIUM OXIDES. Sipos, L.; Branica, M. (Inst. Ruder Boskovic, Zagreb). J. Polarogr. Soc., 14: 3-6(1968).

The sample was dissolved in ortho-phosphoric acid, and after dilution with sulphuric acid hexavalent uranium was determined polarographically. Uranium present in the solution was oxidised with ceric ions to the hexavalent state. The oxidised sample was diluted by the mixture of ortho-phosphoric and sulphuric acid to the required concentration and then subjected to polarography. The O/U ratio was calculated from the limiting currents and dilution. It is not important to know the weight of the sample accurately, but it should be between 0.1 and 50 mg if the O/U ratio of the sample is between 2.5 and 2.001. The coefficient of variation for the proposed method is about 0.6%. (auth) (UK)

35755 ANALYSIS OF TELLURIDES OF LEAD AND TIN BY AUTOMATIC TITRATIONS. Cornwell, J. C. (Massachusetts Inst. of Tech., Lexington); Cheng, K. L. Anal. Chim. Acta, 42: 189-97(Aug. 1968).

An analytical method based on automatic potentiometric EDTA and redox titrations was developed for the analysis of tellurides of lead and tin. First, the sum of lead and tin is titrated at pH 4.5 by adding a known excess of EDTA and back-titrating with a standard lead solution. After addition of ammonium fluoride to mask the tin, the EDTA released from the Sn–EDTA complex is titrated with standard lead solution. Alternatively, after the determination of total lead and tin, lead may be determined by back-titration with standard lead on a separate sample aliquot using tartaric acid to mask the tin. Tellurium is separated as tellurous acid, which is then dissolved in a dilute sulfuric acid solution and oxidized by permanganate at room temperature; the excess permanganate is back-titrated with iron(II) solution automatically. This titration may also be used to determine tellurium in the presence of lead and tin after treatment with perchloric acid. Accuracies of 0.1 to 0.2% can be obtained. (auth)

35756 AN IMPROVED PROCEDURE FOR THE MEASUREMENT OF ^{15}N CONTENT BY MASS SPECTROMETRY. Baiestrieri, Ciro (Univ. of Naples). Life Sci., 7: 269-74(Mar. 15, 1968).

Some modifications for an improved technique in the mass spectrometer analysis of ^{15}N content of ^{15}N-enriched compounds are presented. A new procedure was used for eliminating interfering gases from the samples using modified Rittenberg tubes. Air correction was found to be useless if freezing and thawing of the samples was repeated 3 times or more. It was shown that the residual air is negligible after freezing and thawing samples 3 times so that under these conditions it is not necessary to make any correction for air contamination. The described method allowed the estimation of gaseous samples containing as little as 10 μg of N_2. (BBB)

35757 SPECTROPHOTOMETRIC DETERMINATION OF SCANDIUM WITH 3,5,7,4'-TETRAHYDROXYFLAVONE. Garg, B. S.; Trikha, K. C.; Singh, R. P. (Univ. of Delhi). Anal. Chim. Acta, 42: 343-6(Aug. 1968).

The spectrophotometric determination of Sc in the presence of Y and other rare earths using 3,4',5,7-tetrahydroxyflavone, which gives a deep yellow color with Sc, is reported. Maximum color was attained almost immediately and was stable for ca. 24 hr at room temperature. Solutions containing up to 1.8 ppM of Sc and a ca. 5-fold excess of the reagent were prepared at pH 3.0 and the solutions were made up to 10 ml and contained 50% (v/v) of ethanol. The absorption was measured at 415 nm against the reagent blank. The tolerance limits for various elements are reported. (D.H.M.)

35758 SPECTROGRAPHIC ANALYSIS OF PLUTONIUM FOR TWENTY-TWO TRACE IMPURITIES BY THE D.C. ARC METHOD. Dhumwad, R. K.; Joshi, M. V.; Patwardhan, A. B. (Bhabha Atomic Research Centre, Bombay). Anal. Chim. Acta, 42: 334-7(Aug. 1968).

In order to avoid the health hazard problem in arcing of large quantities (100 mg) of plutonium oxide, excitation of impurities separated from the plutonium sample was used in the spectrographic determination of 22 trace impurities in Pu. The bulk of the Pu was therefore removed by anion exchange. Details of the line pairs and the range of determination with the standard deviations at the 67% confidence level are tabulated. The detection limits of the method are compared with those of other methods. The enhancement of line intensities for Zr and other elements by addition of hydrofluoric acid is discussed. The impurities determined were Al, Ba, Ca, Cr, Cu, La, Mo, Ni, Nb, Tl, V, Zr, Sb, Bi, B, Cd, Fe, Pb, Mg, Mn, In, and Zn. (D.H.M.)

35759 LASER MICROPROBE SAMPLING FOR QUALITATIVE ANALYSIS. Cerrai, E.; Trucco, R. Energ. Nucl. (Milan), 15: 342-44(May 1968).

The instrumental assembly for spectrochemical analysis with laser sampling is described. Studies were made of tungsten microdiffusion in uranium dioxide, inclusions in neoprene, and inclusions in sintered uranium oxides. (M.C.G.)

35760 DETERMINATION OF THE RADIO-CONTAMINANTS IN THE POOL-WATER OF A REACTOR. Kostalas, H. A.; Armiriotes, J. (Nuclear Research Center, Athens). Health Phys., 15: 84-7(July 1968).

The determination of radioisotopes in the moderator of the GRR-1 reactor (NRC-Democritus-Athens), which is a 1 M swimming pool type reactor, is described. To avoid distorting the spectrum of contaminants, samples of water were drawn directly from the pool, through a PVC tube. Short-lived isotopes were detected using a 3 in. dia by 3 in. thick NaI(Tl) crystal situated at the end of the sampling line. The only radioisotope detected with half-life of less than 1 mm was ^{16}N which has a half-life of 7.3 sec. Radioisotopes having half-lives of the order of tens of minutes were estimated by collecting 1 l samples of water in a 3 l beaker and monitoring their activities using the 3 in. × 3 in. NaI (Tl) detector, immersed in the liquid in the beaker. (P.C.H.)

35761 RAPID BIOASSAY METHODS FOR PLUTONIUM, NEPTUNIUM, AND URANIUM. Butler, F. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Health Phys., 15: 19-24(July 1968).

Very sensitive and rapid methods were developed to determine plutonium, neptunium, and enriched uranium in urine. Chloride complexes of the actinides were extracted from oxidized urine salts with the liquid ion exchanger tri-isooctylamine (TIOA). The actinides were back-extracted and counted on low-background solid-state counters. All three actinides are exchanged in 10 sec from an 8N HCl solution of urine salts with TIOA dissolved in xylene. They can be back-extracted collectively from the organic phase with 0.1N HCl to determine total alpha activity, or they can be stripped individually. When stripped individually, plutonium is adjusted to Pu(III) and stripped from the TIOA with 8N HCl containing 0.05M NH_4I; Np(IV) is stripped with 0.02N HF in 4N HCl; and finally U(VI) is stripped with 0.1N HCl. These procedures yield low-solid mounts (1.5 mg) containing greater than 95% of the actinides, with no other radioactive contaminants; lengthy electrodeposition is eliminated. The mounts are assayed with counters having 30% efficiency and backgrounds less than 5 counts/day. Sensitivity is 0.1 dis/min of alpha activity per 1.5 liter for a 250-ml urine sample. (auth) (UK)

35762 GAS COUNTING OF TRITIUM WITH PARTICULAR REFERENCE TO COUNTER BACKGROUND. Ward, P. R. B.

(Univ. of California, Berkeley); Wurzel, P. Int. J. Appl. Radiat. Isotop., 19: 529-33(June 1968).

Several factors in the measurement of tritium in water by conversion of samples to ethane, followed by gas counting are discussed. Sources of contamination in the gas preparation proved difficult to isolate, and the tests undertaken are described. Data on counter operation are presented and the minimum detectable amount of tritium imposed by variations in the background counting rate and the error due to electrolysis is stated. The optimum configuration of a shield of lead, boron in paraffin wax, and concrete is shown. The ultimate background achieved with this shield was 0.8 counts/min at an ethane pressure of two atmospheres. (auth) (UK)

35763 SUBSTOICHIOMETRY IN RADIOCHEMICAL ANALYSIS. Ruzicka, J.; Stary, J. International Series of Monographs in Analytical Chemistry, Vol. 30. Oxford, Pergamon Press, 1968. 160p. 55s.

Procedures that have been developed for the substoichiometric determination of many elements by neutron activation and isotope dilution analysis, are described. The procedures may easily be automated. Discussion is presented on the following main headings: neutron activation analysis; isotope dilution analysis; general techniques and preliminary experiments; procedures for substoichiometric determination of traces of elements; analysis of radioactive materials; automation; comparison of substoichiometric isotope dilution analysis and other radiometric methods; and trends in substoichiometry. (UK)

35764 DETERMINATION OF COPPER IN GEOLOGICAL MATERIAL BY NEUTRON ACTIVATION AND GAMMA-GAMMA COINCIDENCE SPECTROMETRY. Mickelsen, O. B.; Steinnes, E. (Institutt fuer Atomenergi, Kjeller, Norway). Talanta, 15: 574-8(June 1968).

The copper content of some geological samples was determined by thermal neutron activation and subsequent coincidence gamma spectrometry, taking advantage of the 180° annihilation quanta of ^{64}Cu. By this means the interference of ^{24}Na, which is often the major gamma activity induced in geological materials, is greatly reduced. The method is precise to about ±5%, and the error is of the same order. The method should be especially attractive for application to samples with a copper content of 100 to 1000 ppM. (auth) (UK)

35765 DETERMINATION OF SILICON, PHOSPHORUS, AND SULFUR IN ALLOY STEEL BY NEUTRON ACTIVATION ANALYSIS. Nadkarni, R. A.; Haldar, B. C. (Inst. of Science, Bombay). Anal. Chim. Acta, 42: 279-84(Aug. 1968).

Silicon, phosphorus, and sulfur in alloy steel were determined by neutron activation analysis involving rapid radiochemical separation procedures. The standard deviations for silicon, phosphorus, and sulfur were 1.6%, 2.3%, and 2.4%, respectively; the sensitivity limits were 3.2, 0.20, and 2.50 ppM, respectively. The three constituents could be determined in alloy steel within 2 hr of the irradiation. (auth)

35766 NONDESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF BIOLOGICAL MATERIAL. Rakovic, Miloslav (Charles Univ., Prague). Acta Univ. Carolinae, Med., Monogr., 28: 101p (1967).

Nondestructive methods for the determination of Na, K, and P in biological material were developed. High sensitivity resulted from the application of neutron activation analysis. The use of integral measurement guaranteed that the sensitivity of the method was not reduced as would occur in the use of γ spectrometry. Another advantage of the integral measurement was in the fact that the laboratory does not need to be equipped with a γ spectrometer. Only in samples with a higher content of K than Na can there be a certain increase of analytical results for Na beyond the correct values. A correction by means of the suggested correction relation can be carried out with sufficient accuracy in these cases. The nondestructive technique is checked in the case of K for the determination of the chemical by isolation of $KClO_4$ before activation. The analysis of P is less attractive because of a 14-day cooling period. A detailed development of a practical correction for the elimination of a contaminating radionuclide in neutron activation analysis is given. A new method for evaluation of the accuracy of neutron activation analysis is suggested. (BBB)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 35829, 35879, 35900, 35911, 35935, 36470, 36545, 36774, and 37058.

35767 (AEC-tr-6776) ADSORPTION OF IONS ON METAL OXIDE SURFACES IN AQUEOUS SOLUTIONS. Herczynska, Elwira (Institute of Nuclear Research, Warsaw (Poland)). Translated from report INR-634/V/C. 135p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 7003. (P.C.H.)

35768 (AEC-tr-6939) THERMAL DECOMPOSITION OF SOME NITRATES. Karavaev, M. M.; Kirillov, I. P. Translated from Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 2: 231-7(1959). 12p. Dep. CFSTI.

By thermographic investigation the temperature intervals were established for the various intermediate processes occurring in the thermal decomposition of the nitrates of aluminum, chromium, iron, manganese, cobalt, and nickel. By analysis of the gaseous decomposition products by an infrared spectrometer it was established that in them are vapors of nitric acid, the concentration of which varies as a function of the type of nitrate and the decomposition temperature. It was shown that the nitric acid is a primary product of the decomposition of the nitrate or a product of the interaction of N_2O_5 and H_2O, and is not a result of synthesis from NO_2 and H_2O. The temperatures of the appearance of nitric acid vapors in the gas phase, which can be taken as the temperatures of the start of decomposition of the nitrates, were established. (auth)

35769 (AI-AEC-Memo-12688) OXIDATION EXPERIMENTS ON ORGANIC REACTOR COOLANT. Stahl, Q. R.; Tiedeman, G. T. (Atomics International, Canoga Park, Calif.). Apr. 22, 1968. 82p. Dep. CFSTI.

Commercial Santowax OM was oxidized with an oxygen-argon gas mixture. The Santowax OM was circulated around a loop countercurrent to the gas mixture bubbling up through the coolant in a reaction vessel that contained 90% of the liquid. The oxidation was studied at various temperatures (350 to 620°F), oxygen concentrations (1 to 4% O_2 in Ar), gas flow rates (0.15 to 0.66 moles/min), and pump rates (9 to 29 gph). The effluent gas stream was monitored continuously for oxygen and carbon dioxide content. The gas stream was also sampled periodically for off line analysis by mass spectrometry. Coolant samples taken during the experiments were analyzed for the oxygen containing compounds. The oxidation rate of freshly distilled Santowax OM at high temperature (≥580°F) initially increased rapidly to a maximum then slowly decreased by a factor of 3 to 5 to a steady-state oxygen consumption rate (about 20 to 25% of the oxygen being consumed). Nonterphenyl impurities present in the distilled Santowax OM caused the peaking in the oxidation rate and also resulted in a ten-fold higher steady-state oxygen uptake rate. The activation energy for the oxidation of Santowax OM was calculated at 13 ± 3 kcal/mole. The production rate of oxygenated compounds including the gaseous products and bound oxygen compounds in the coolant, appeared to follow the oxygen consumption rate; thus at high temperatures the production rates rapidly increased then slowly decreased to a steady-state rate. At high temperatures a film containing about 4% oxygen was formed in the reaction vessel but not during the low-temperature oxidations. The data also indicated that under the conditions studied the oxygen consumption rate had a first order dependence on oxygen concentration, decreased with increased gas flow and decreased with decrease in pump rate. An irradiation dose of $\sim 3 \times 10^6$ rad/hr had no significant effect on the oxidation rate. (auth)

35770 (BNWL-SA-1849) REACTION OF SULFUR DIOXIDE WITH GRAPHITE. Giberson, R. C.; Tingey, G. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 7, 1968. Contract AT(45-1)-1830. 12p. (CONF-680608-5). Dep. CFSTI.

From American Chemical Society Meeting, Portland, Ore.

Studies were made on the rate of graphite removal by exposure to small partial pressures of SO_2 carried by a helium gas stream. The effects of added CO and added CO_2 on the weight loss rates were also determined. The primary products in the system C-SO_2-He appeared to be CO and solid S, in the temperature range of 700 to 1400°C. Secondary products COS, CO_2, and CS_2 were observed at high temperatures or when CO was added to the inlet gas. It is suggested that the CO competes with the graphite for the activated SO_2. This process requires a graphite surface to be significant. (P.C.H.)

35771 (GAT-P-43) FLUORINATION OF ALL ENRICHMENTS OF URANIUM OXIDES. Crawford, J. G. (Goodyear Atomic Corp., Piketon, Ohio). June 24, 1968. Contract AT(33-2)-1. 10p. (CONF-680613-1). Dep. CFSTI.

From Fluoride Volatility Meeting, Golden, Colo.

The equipment, operating procedures, and system characteristics, for a uranium oxide to uranium hexafluoride conversion facility for processing 20,000 kg of U per year are described. Design

of the flame tower and associated subsystems, such as pneumatic unloading and transfer for oxide, feed screw and disperser for the tower, ash removal, filtering, cold trapping, and liquid UF_6 loading into cylinders, was dictated by the need for safe nuclear geometry, so that all enrichments of uranium could be processed, and by the need for maximum protection of personnel from exposure to the uranium materials. Respiratory equipment is not required since the parts of the process apt to allow release of airborne material are additionally enclosed by glove boxes. (auth)

35772 (JINR-P7-3783) OPYTY PO KHIMII ELEMENTA 104-KURCHATOVIYA. II. KHIMICHESKOE ISSLEDOVANIE SPONTANNO DELYASHCHEGOSYA IZOTOPA S PERIODOM POLURASPADA 0,3 SEKUNDY. (Experiments on Chemistry of Element 104: Kurchatovium. II. Chemical Investigations of a Spontaneously Fissioning Isotope of 0,3 sec Half-Life). Zvara, I.; Chuburkov, Yu. T.; Tsaletka, R.; Shalaevskii, M. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 26p. (In Russian). Dep.

For the purpose of chemical identification and investigation of a spontaneously fissioning nuclide of 0.3 sec half-life (obtained in 1964 at Dubna and identified by the nuclear method as Element 104 isotope) the absorption of molecules of its chloride from the gas phase on solid surfaces was compared with that of chlorides of known elements. The chloride is adsorbed approximately in the same way as chloride of Hf, but more than niobium chloride and considerably less than the chlorides of In, Th, Cm, Cf, Fm, and of Element 102. The heat of vaporation of the chloride of Element 104 was estimated to be 16 to 23 kcal/mole. Total of nuclear and chemical data shows that the isotope investigated belongs to the element of the Periodic Table with the atomic number 104, which is close in properties to Hf and must be in subgroup IV B. (auth)

35773 (KY-556) STEAM BATH CYCLE REQUIRED FOR ISOTOPIC HOMOGENEITY OF 14-TON UF_6 CYLINDER. Smith, R. F. (Paducah Gaseous Diffusion Plant, Ky.). June 17, 1968. Contract W-7405-eng-26. 12p. Dep. CFSTI.

It was concluded that 12 hours in a steam bath at 200 ± 5°F is adequate to ensure isotopic homogeneity for a 14-ton UF_6 cylinder moved from the yard in winter months. The requirement is that the steam bath surrounding the cylinder be maintained at 200°F for 12 consecutive hours prior to sampling. Total bath time necessary is variable, depending on steam line capacity and beginning temperature of cylinder, which at the outset acts as a heat sink. Thus, assay homogeneity may be assured by bringing bath temperature up to 200°F and maintaining it at that level 12 hours before sampling. This procedure applies when the ^{235}U assay range of UF_6 drained into the 14-ton cylinder does not exceed 20% of the average cylinder assay. This procedure is applicable to UF_6 cylinder Model 48F, and is shown to be conservative for use in providing isotopic homogeneity to Model 30A (2½ ton) or 48A (10 ton). The procedure may also be used for any cylinder with a diameter ≤4 ft. and a length ≤12 ft. (auth)

35774 (NIJS-R-525) DRUCKSYNTHESE VON URANHEXAFLUORID. (Synthesis of UF_6 under Pressure). Slivnik, J.; Smalc, A.; Zemva, B. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Feb. 1968. 5p. (In German). (CONF-670447-1). Dep.

From Conference on Inorganic Fluorine, Leicester, England.

The synthesis of uranium hexafluoride from U_3O_8 and elemental fluorine under pressure is reviewed. Elemental fluorine was obtained in an electrolytic cell. The reaction product was isolated by sublimination into a vacuum. Experiments were also carried out using UF_4 or UO_2 as the uranium-containing component. (M.C.G.)

35775 (NYO-1158-25) ANNUAL PROGRESS REPORT, JUNE 1, 1967-MAY 31, 1968. (Princeton Univ., N. J.). June 1968. Contract AT(30-1)-1158. 7p. Dep. CFSTI.

Research is reported on: films of sodium deposited on the surfaces of the pores of Vycor glass, reactions of molecular sieves, ESR studies of zinc oxides, production of methyl radicals in aqueous solution and chemiluminescence in their reactions with oxygen, double resonance of copper in Tutton salt, production of the O_2^- radical by photolysis of hydrogen peroxide on Vycor glass, and the preparation of platinum and palladium particles of controlled size. (M.C.G.)

35776 (ORNL-TM-2105) THE CHEMICAL EQUILIBRIA OF FISSION-PRODUCT-NUCLEAR FUEL MIXTURES: THE URANIUM OXYGEN AND THE URANIUM-OXYGEN-STRONTIUM SYSTEM. Fontana, M. H. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 272p. Dep. CFSTI.

Thesis. Submitted to Purdue Univ., Lafayette, Ind.

Methods of using multi-component chemical equilibrium computer techniques have been developed for computation of chemical equilibria in the gas phase around a melted fuel element, and they have been tested against published Knudsen cell-mass spectrometer data for the U-O system. This served as a base point from which the U-Sr-O system was extended. It was found that for the U-O systems, the gas phase composition (i.e., the partial pressures of U, O_2, UO, UO_2, and UO_3) could be predicted as a function of the O/U ratio in the solid phase, given the equilibrium constants of formation of the compounds of interest and the experimentally determined total pressure and atom ratios in the gas phase. The U-Sr-O system was estimated by relating the chemical species in the gas phase (U, O_2, UO, UO_2, UO_3, Sr, and SrO) to a computed equilibrium composition of the same species in the condensed phase. This does not imply that the condensed phase actually contains these compounds, but this is a useful construct for handling the effects of non-stoichiometry in the UO_{2+x}. The pressures of the strontium bearing species were then computed by using estimated Henry's law coefficients. The effect of excess oxygen pressure, variation in activity coefficients, variability in the thermodynamic properties, and changes in O/U (solid) ratios were investigated. The results showed that the total amount of strontium in the gas phase is most highly affected by the oxygen-to-uranium ratio in the solid, the equilibrium constant of formation of SrO, and the activity coefficient of strontium. Reducing conditions enhance the total amount of strontium in the gas phase, as confirmed by independent experimental data on fission product release. Computer programs were written to generate tables of thermodynamic data needed by the equilibrium computer programs, inasmuch as complete tables of data are not available for most of the compounds of interest to nuclear safety. (P.C.H.)

35777 (ORNL-TM-2216) ELECTRON ATTACHMENT TO ORGANIC MOLECULES. Blaunstein, R. P.; Christophorou, L. G. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 111p. Dep. CFSTI.

Thesis. Submitted by R. P. Blaunstein to Univ. of Tennessee, Knoxville.

An apparatus was built for the measurement of the rates of electron attachment to molecules in the gas phase in the temperature range from 25 to 210°C. Modifications allowed attachment studies for molecules that are in the crystalline form at 25°C and thus exhibit low vapor pressures. Electron attachment rates and mean electron attachment cross sections as a function of mean electron energy for dissociative attachment to the aliphatic compounds CH_2Cl_2, $CHCl_3$, CCl_4, 1,1,1-$C_2H_3Cl_3$, 1,1,2-$C_2H_3Cl_3$, and C_2HCl_3 were measured directly using the constructed equipment, and mean electron attachment cross sections were calculated for 16 additional aliphatic hydrocarbons from previously known attachment rates. It is demonstrated that for electron energies below 1.0 eV, especially for electron energies close to thermal, the mean electron attachment cross section as a function of mean electron energy is a good approximation to the electron attachment cross section as a function of electron energy. The attachment cross sections for all the aliphatic compounds peak at or near thermal energies. The dissociative electron attachment resonance processes at energies >½ kT are found to agree very well with available beam data and with theoretical considerations on resonance dissociative electron attachment to molecules. By invoking a model for enzymatic inactivation, a broad correlation was observed between toxicity indices and the thermal values of the mean electron attachment cross sections for several of the aliphatic hydrocarbons studied. Nondissociative electron attachment cross sections were measured for the aromatic hydrocarbons benzene, naphthalene, phenanthrene, triphenylene, chrysene, pyrene, anthracene, perylene, and the carcinogenic hydrocarbon 1,2 benzanthracene. All these hydrocarbon molecules exhibit sharp attachment cross sections peaking at thermal energies. The peak attachment cross section varies from $<10^{-20}$ cm² for the single ring benzene molecule to a maximum of 1.93×10^{-15} cm² for the carcinogenic molecule, 1,2 benzanthracene. A study of the temperature dependence of the electron attachment rate yields a v^{-1} velocity dependence for the thermal electron attachment cross section for triphenylene, pyrene, anthracene, and 1,2 benzanthracene. The electron attachment cross sections are shown to depend not only on the molecular electron affinity but also on the vibrational degrees of freedom and molecular structure in general. The biological implications of electron attachment to aromatic hydrocarbons are discussed in light of the present results. (auth)

35778 (ORNL-TM-2268) STUDY OF GAS-EVOLUTION FROM SOL-GEL THORIA AND THORIA-URANIA. Cordiner, J. B.; Dean, O. C. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 27p. Dep. CFSTI.

This gas-evolution study was designed to determine the sources of gases from sol-gel thoria and to indicate the steps that need to be taken to limit undesirable quantities and species to a minimum. A test program was instituted to check the most significant trends

from earlier data and to obtain additional information on these gases. The findings indicated that a number of sources were responsible. Carbon and nitrogen materials in the interior of the calcined oxide are the main source of carbon monoxide, carbon dioxide, and nitrogen in the evolved gases, and their contents should be kept to the economic minimum in the unfired sol-gel. Nonstoichiometric oxygen in the calcinated oxide is responsible for free oxygen but may be kept to a minimum by use of a reducing calcining atmosphere such as 4% hydrogen-argon. Water vapor and carbon dioxide are readily adsorbed on the surface of the pores and are responsible for most of the H_2O and part of the CO_2. These should be kept to the practicable minimum by minimizing exposure of the finely ground oxide to atmospheric water vapor or carbon dioxide. The reducing atmosphere employed during calcination is responsible for most of the free hydrogen. Hydrogen may be minimized either by using a hydrogen-free calcination atmosphere throughout or during the last portion of the calcination, so that a minimum of hydrogen becomes entrapped as bound water within the particles. An outgassing temperature of 1200°C is too low for adequate gas release from coarse oxide particles. Optimum combinations of temperature and duration of outgassing should be established to make laboratory tests on calcined fuel oxides comparable to reactor service conditions in thoroughness of release of gaseous products. (auth)

35779 (SC-RR-68-162) FLASH PHOTOLYZED REACTIONS MONITORED BY TIME-OF-FLIGHT MASS SPECTROMETRY. Meyer, R. T. (Sandia Corp., Albuquerque, N. Mex.). Apr. 1968. 20p. (CONF-680308-11). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

The techniques of flash photolysis and time-resolved mass spectrometry were combined for the study of fast gas phase reactions. The apparatus provides an incident ultraviolet light flux of 1.0×10^{18} quanta per cm^2 per flash and a spectrometer sensitivity of 5×10^{-8} mole per liter. Time resolution is 1.4 μsec at successive 50 μsec intervals. The following chemical systems were investigated: nitrogen dioxide sensitized reaction between hydrogen and oxygen; decomposition of nitromethane; termolecular recombination of iodine atoms in the presence of nitric oxide; and reaction of excited iodine ($^2P_{\frac{1}{2}}$) atoms with methyl iodide. (auth)

35780 (Y-1614) CRYSTALLIZATION AND PURIFICATION OF BORON METAL POWDER. Trent, P. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 8, 1968. Contract W-7405-eng-26. 62p. Dep. CFSTI.

Two methods were found that can be used to transform impure, low-density amorphous boron to a higher-purity, higher-density crystalline boron metal powder. Amorphous boron metal powder was placed in HBR-grade boron nitride containers and heated to 2,000 to 2,150°C in an inert-atmosphere tungsten suscepted furnace. In the second method, the boron metal powder was passed through a sheath-stabilized helium plasma flame onto a water-cooled target to produce an essentially massive body. Amorphous normal boron produced by reduction of the oxide (B_2O_3) by magnesium metal was crystallized and purified to greater than 99 wt % boron by both of these methods. Electrolytic-cell-produced amorphous boron-10 metal powder was crystallized and purified to greater than 97 wt % boron by both of these methods. (auth)

35781 FORMATION OF BIVALENT THORIUM IN POTASSIUM CHLORIDE MELTS. Kudyakov, V. Ya.; Smirnov, M. V.; Chukreev, N. Ya.; Posokhin, Yu. V. At. Energ. (USSR), 24: 448-52(May 1968). (In Russian).

The results are reported for studies on the reactions of metallic thorium with both pure potassium chloride melts and those containing 3.4% by weight $ThCl_4$ at 800 to 970°C. As established by direct measurements, metal reacts with pure potassium cations: $Th_{(solid)} + 2nK^+_{(melt)} \rightleftharpoons Th^{2n+}_{(melt)} + nK^+_{2(melt)}$. The equilibrium potentials were measured for the thorium electrode against the chlorine. The values of apparent standard potentials Th(II)/Th and Th(IV)/Th $E^*_{Th(II)/Th} = -2.97 + 6.3 \cdot 10^{-4}\ T$ and $E^*_{Th(IV)/Th} = -3.17 + 6.7 \cdot 10^{-4}\ T$ (V)) were determined from the experimental data. The thermodynamic values (ΔG^*, ΔH^* and ΔS^*) and equilibrium constant were calculated for the reaction $Th_{(solid)} + Th^{4+}_{(melt)} \rightleftharpoons 2\ Th^{2+}_{(melt)}$: $\Delta G^* = -31000 + 8.04 \cdot 10^3 \cdot T$ cal/d.mole; $\lg K = 0.805 - 4045/T$. (auth)

35782 HIGH TEMPERATURE THERMODYNAMIC DATA FOR $UO_{2\pm x}$. Markin, T. L.; Wheeler, V. J.; Bones, R. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 30: 807-17(May 1968) (AERE-R-5562).

A new technique of gas equilibration in a sealed silica system was developed to obtain thermodynamic data for UO_{2-x} at temperatures 2200 to 2400°K and for UO_{2+x} at 1600 to 1700°K. UO_{2-x}, in Mo or W crucibles, was equilibrated with a reference metal/metal oxide mixture (Cr/Cr_2O_3 or Nb/NbO) held at a lower temperature; oxygen was transferred by means of a H_2O/H_2 gas mixture. The composition of this mixture was fixed by the reference metal/metal oxide, and hence the oxygen potential of UO_{2-x} could be calculated. The O/U ratio at equilibrium was determined by partial oxidation of small samples of UO_{2-x} to a hyperstoichiometric composition by means of a measured volume of oxygen, followed by reduction of the sample by CO to a reference composition, defined by an oxygen potential close to the stoichiometric composition. The UO_{2+x} system was studied by a similar technique, employing Co/CoO as the reference material, with CO_2/CO as the gas phase. (auth) (UK)

35783 VIBRATIONAL ANALYSIS OF GASEOUS BOROXINE. Grimm, F. A.; Barton, L.; Porter, Richard F. (Cornell Univ., Ithaca, N. Y.). Inorg. Chem., 7: 1309-16(July 1968).

With an improved method for the preparation of boroxine it was possible to obtain infrared spectra of the gaseous compound at pressures up to 20 mm. Infrared spectra were obtained for the isotopic species $H_3{}^{11}B_3{}^{16}O_3$, $H_3{}^{10}B_3{}^{16}O_3$, $H_3{}^{11}B_3{}^{18}O_3$, $D_3{}^{11}B_3{}^{16}O_3$, and $D_3{}^{11}B_3{}^{18}O_3$. The spectra are discussed in relation to two possible molecular structures: a planar model (D_{3h} configuration) and a nonplanar model (C_{3v} configuration). Spectral evidence from the partially deuterated species $H_2DB_3O_3$ and $HD_2B_3O_3$ support the nonplanar model and similarities between the spectra of boroxine and borazine are discussed. A normal-coordinate analysis based on several isotopic species yielded a set of simple valence force constants including one interaction constant, which could predict most of the observed vibrational frequencies to within 3%. (auth)

35784 BUTANOLYSIS OF B-TRIS(PHENYLETHYNYL)BORAZINE IN 1-BUTANOL–DIOXANE MIXED SOLVENT. Yoshizaki, Tamotsu; Watanabe, Haruyuki; Nakagawa, Toshio (Shionogi and Co., Ltd., Osaka). Inorg. Chem., 7: 1304-6(July 1968).

The alcoholysis of B-tris(phenylethynyl)borazine was investigated in 1-butanol–dioxane mixed solvent in the presence of triethylamine as catalyst. The reaction was followed spectrophotometrically and was found to be first order with respect to the sample as well as the amine concentration. Distinct features were found in the activation parameters; the Arrhenius activation energy was 4.79 kcal/mol and the activation entropy −45.3 eu. Solvent isotope effect and solvent composition effect on k_{obsd} were also examined. Analyses of these data led to the conclusion that butanol hydrogen-bonded to an amine or to a triethylammonium butylate ion pair attacks the borazine ring in the rate-determining step. (auth)

35785 ZEEMAN SPLITTING OF VIBRONIC LEVELS FOR OCTAHEDRAL ACTINIDE AND LANTHANIDE COMPLEXES, FREE AND IN CRYSTALS. Satten, R. A.; Johnston, D. R.; Wong, E. Y. (Univ. of California, Los Angeles). Phys. Rev., 171: 370-7(July 10, 1968).

The splitting of vibronic levels in the presence of a magnetic field is determined in terms of a few parameters for an octahedral complex in the limit of Zeeman interaction (A) small compared to vibronic splitting, (B) comparable to vibronic interaction, and (C) large compared to vibronic interaction. The relative density of phonon states controls the size of the vibronic splitting in crystals, and is influential in determining whether case A, B, or C above applies. Data for cubic Cs_2UBr_6 show that vibronic levels are split according to the parent electronic level, illustrating case C, because the vibronic splitting is much smaller than that which would have occurred for a local-mode or free-ion complex. The free UBr_6^{2-} belongs to case A; the reduction to case C is due to the effect of the phonon relative density of states. The vibronic Zeeman effect is thus a tool for learning about the relative density of phonon states, particularly in localized modes. Similar conclusions apply to vibronic shifts, so that for nonlocalized phonons the vibronic spectra should reflect the density of states of the phonons without the necessity of correction for vibronic shifts or splittings. For case A, particularly applicable to the free-ion complex, the Zeeman splitting of a vibronic level is isotropic and consists of three equally spaced levels with a g value that is one-half that of the parent electronic state. Some general relations between vibronic level differences are derived, which are independent of particular models and values of matrix elements. (auth)

35786 DETERMINATION OF THE LIMITS OF THE PHASES IN THE SYSTEM U–O BY OXYGEN TRANSFER. PHASE DIAGRAM FOR THE REGION $2.19 < O/U < 2.63$ AND $1080 < \Theta°C < 1200$. Kotlay, Alain; Gerdanian, Paul; Dode, Maurice. (Faculte des Sciences, Orsay, France). J. Chim. Phys., 65: 687-91(Apr. 1968). (In French).

The limits of the phases of the systems U–O between 1,080 and 1,200°C and for $2.19 < O/U < 2.63$ have been obtained by the method of transfer of oxygen between oxides using a thermobalance. The values found confirmed previous results; in particu-

lar O/U = 2.2400 was measured for the highest limit composition of the phase U_4O_9, which leads to a phase diagram different from that of others. (auth)

35787 STRUCTURAL STUDY OF THORIUM TETRAFORMATE AT ITS DIFFERENT DEGREES OF HYDRATION. Chevreton, Maurice; Claudel, Bernard; Mentzen, Bernard (Institut National des Sciences Appliquees, Lyon). J. Chim. Phys., 65: 890-4(May 1968). (In French).

The three thorium tetraformates: $Th(HCOO)_4$, 3 H_2O, $Th(HCOO)_4$, 2/3 H_2O, and $Th(HCOO)_4$ were characterised by their x-ray diffraction diagrams. For the trihydrate a P monoclinic unit cell: a = 6,77 ± 0,01; b = 8,81 ± 0,02; c = 9,61 ± 0,02 Å; β = 109° 15′ ± 5′, and a pseudo-orthorhombic nonconventional B double unit cell were determined. The space group is $P2_1$ (C_2^2) or $P2_1/m$ (C_{2h}^2). For the anhydrous formate a P orthorhombic unit cell was found: a = 6,78 ± 0,02; b = 7,32 ± 0,04; c = 16,92 ± 0.06 Å. The probable space group is $Pmn2_1$ (C_{2v}^1) or $Pmmn$ (D_{2h}^{13}). (auth)

35788 GENERAL PROPERTIES OF THE HYDROGEN EXCHANGE REACTION CATALYZED BY THE SOLUBLE SUCCINIC DEHYDROGENASE OF SINGER FROM BOVINE HEART. Huefner, Michael; Buckley, Linda M.; Hollocher, Thomas C. (Brandeis Univ., Waltham, Mass.). J. Biol. Chem., 243: 3473-81(June 25, 1968).

Kinetic studies were made on the catalysis of tritium exchange from meso-2,3-ditritiosuccinate to water by soluble succinic dehydrogenase from bovine heart. Tritium exchange appeared to proceed directly from an enzyme-succinate complex. Time-dependent changes in the exchange activity were observed in the presence of fumarate. Fumarate and fumarate analogues either enhanced or inhibited the exchange reaction depending on concentration and other conditions. Oxygen enhanced the exchange rate several-fold in an easily reversible manner which cannot be attributed to the autoxidation of succinate. Attempts to detect a transfer of tritium from succinate to succinic dehydrogenase directly and indirectly by the transfer of tritium from succinate to 2-methylfumarate to yield tritiated 2-methylsuccinate via the succinate-fumarate dismutation reaction were unsuccessful. Exchange rates were dependent on pH, and the maximum in the pH rate profile occurs at pH 6.9 with an apparent turnover number for meso-2,3-ditritiosuccinate of about 5 moles of succinate × min^{-1} × moles of $flavin^{-1}$ at 24°. Succinate K_m is relatively insensitive to pH and values of $2 \pm 0.5 \times 10^{-4}$ M were obtained from pH 6.8 to 7.6. K_I values for oxalacetate and malonate are 0.5 to 1 μmole and 60 to 70 μmole, respectively, at pH 6.9. Solvent isotope effects arose to a large extent from an apparent shift in the pH rate profile toward lower pH values in deuterated water. Succinate K_m remained essentially unaffected in deuterated water. (auth)

35789 STUDIES ON THE MECHANISM OF HYDROGEN EXCHANGE BETWEEN SUCCINATE AND WATER CATALYZED BY THE SOLUBLE SUCCINIC DEHYDROGENASE OF SINGER FROM BOVINE HEART. Huefner, Michael; Hollocher, Thomas C. (Brandeis Univ., Waltham, Mass.). J. Biol. Chem., 243: 3482-92(June 25, 1968).

The equilibrium exchange of hydrogen between the 2,3-methylene positions of succinate and water was studied under aerobic conditions with specifically tritiated and deuterated succinates and soluble succinic dehydrogenase prepared by the method of Singer from bovine heart. The exchange of tritium from racemic 2-tritiosuccinate (racemic-T_1), racemic 2,3-ditritiosuccinate (racemic-T_2), and meso-2,3-ditritiosuccinate (meso-T_2) proceeded to completion and exhibited simple, first order kinetics. The rates of exchange of tritium from racemic-T_1 and racemic-T_2 were identical and 1.35 times faster than that from meso-T_2. The enantiomorphs of racemic-T_1 and racemic-T_2 were not distinguished kinetically. Hydrogen exchange products of deuterated succinates were identified by their infrared spectra. In the exchange of deuterium from 2,2,3,3-tetradeuterosuccinate (D_4) to water, meso-2,3-dideuterosuccinate (meso-D_2) was the only major intermediate detected between D_4 and the final product, succinate. 2-Deuterosuccinate was detected as an intermediate during the exchange of deuterium from racemic 2,3-dideuterosuccinate, but not from meso-D_2. In the exchange of deuterium from D_2O to succinate, meso-D_2 was again the major intermediate detected between succinate and the final exchange product D_4. The exchange of deuterium from succinate to water went to completion regardless of the extent and stereochemistry of deuteration. Hydrogen exchange proceeded mainly through the exchange of trans (RS) pairs of methylene hydrogens, and was analogous to the trans elimination of a proton pair during the oxidation of succinate to fumarate. Kinetic isotope effects appeared to relate only to the nature of trans hydrogen pairs and to be unrelated to the stereochemical differences between labeled enantiomorphs. Activation of succinate seems to involve both hydrogens of a trans pair symmetrically. Thus all four methylene hydrogen atoms are very nearly equivalent kinetically. (auth)

35790 THE FRENCH CHEMICAL INDUSTRY AND NUCLEAR ENERGY. Regnaut, P. (Commissariat a l'Energie Atomique, Paris). Energ. Nucl. (Paris), 10: 147-9(May 1968). (In French).

The chemical industry played a role in the development of nuclear energy. The fields involved are very varied, and mainly concern applied research, the production of reagents, specific materials and appliances of outstanding quality, and the construction of pilot or industrial installations. The period of rapid expansion that led to the attaining of primary objectives was followed by a momentary pause, which the chemical industry could use to prepare for meeting the next stage of industrial development. (auth)

35791 INDUSTRIAL REALIZATIONS FOR THE PRODUCTION OF URANIUM TETRAFLUORIDE, USING THE FRENCH FLUIDIZED-BED PROCESS OF REDUCTION-HYDROFLUORINATION IN TYPE LC FURNACES. Haegi, W.; Verot, L.; Muller, J. Energ. Nucl. (Paris), 10: 152-9(May 1968). (In French).

The engineering and the supplying of plants for the production of uranium tetrafluoride, through application of the reduction-hydrofluorination process developed by the Commissariat à l'Energie Atomique are discussed. The particular characteristics of this technique, its basic principles, the equipment and the industrial installations, and results achieved in the exploitation of these plants are considered. (auth)

35792 PERFORMANCES OF TERPHENYLS AS HEAT-TRANSFER FLUIDS. Giolito, F. Energ. Nucl. (Paris), 10: 220-3(May 1968). (In French).

Characteristics of commercial terphenyls are given, as well as the degree of nuclear purity usually obtained. The problem of terphenyls as nuclear heat-transfer fluids is not discussed, but results on experimental installations are given, results that show the performances of these products. (auth)

35793 DETERMINATION OF THE COMPOSITION AND SOLUBILITY OF THE FERROCYANIDES OF ZINC, COPPER, CADMIUM, AND COBALT BY RADIOCHEMICAL METHODS. Shamaev, V. I. Radiokhimiya, 10: 261-5(1968). (In Russian).

The dependence of the composition of a series of metals on the conditions of the precipitation of these metal ions by Na or K ferrocyanides was investigated. The change of the composition of the ferrocyanides was determined in relation to the precipitation conditions. The solubility of these precipitates was determined, and a comparative determination was made of these solubilities by a radiochemical variation of the Tananaev method. (tr-auth)

35794 REDUCTION OF URANYL IONS BY TRIDECYLAMINE IN NONAQUEOUS MEDIUM. Vdovenko, V. M.; Romanov, G. A.; Skoblo, A. I.; Suglobov, D. N. Radiokhimiya, 10: 255-7(1968). (In Russian).

The reduction of triperchlorate uranyl complexes by tridecylamine in benzene or CCl_4 medium was investigated. The processes occurring in the reduction were determined by infrared spectroscopy. The results showed that the reduced uranium in the organic solution is partially oxidized by the decomposition products of ClO_4^-. (J.S.R.)

35795 SOLUBILITY OF URANYL SALTS IN ETHERS. Vdovenko, V. M.; Suglobova, I. G.; Suglobov, D. N. Radiokhimiya, 10: 182-95(1968). (In Russian).

The results of the investigation of the solubility (extraction) of inorganic uranyl salts in organic solvents and ethers are reported. The solubility isotherms are given for uranyl nitrate in systems of water and diethyl ether, dibutyl ether, and diisopropyl ether. The examination of the behavior of uranyl salts in organic solvents showed that although many of the anions, with the exclusion of the perchlorates, are capable of yielding neutral complexes with uranyl ions with sufficiently high activity of the water, these complexes are polar. (J.S.R.)

35796 IMPACT RECRYSTALLIZATION AND ITS EFFECT ON SORPTION. Melikhov, I. V.; Eval'd, G. Radiokhimiya, 10: 129-37(1968). (In Russian).

The study of the kinetics of the isotopic exchange between NaCl precipitates and stirred solutions and the sorption of Ag by the solid phase made it possible to show the increased mobility of the molecules (ions) of the admixture and macrocomponents in the solid phase caused by the stirring of the suspension. It was determined that in the initial interval of exchange (or sorption) the migration of the material from the liquid phase to the solid phase was described by the diffusion equation in the isotopic medium

with effective diffusion coefficient $q \sim 10^{-13}$ cm²/sec. The size of the effective diffusion coefficient in the interval $100 < \Omega < 1500$ rev/min depends linearly on the intensity of the macrovelocity of the motion of the suspension. (tr-auth)

35797 EFFECT OF PRESSURE ON THE VOLUME OF THE HIGH-PRESSURE (VII) PHASE OF H_2O AND D_2O. Holzapfel, W.; Drickamer, H. G. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. J. Chem. Phys., 48: 4798-4800(May 15, 1968). (COO-1198-510).

The volume of ice VII was measured as a function of pressure to 165 kbar by x-ray diffraction techniques. Similar measurements on D_2O were made to 220 kbar. The majority of the data was taken at −30°C, but isotherms were run at 25°C and attempts were made to measure isobars. Within the accuracy used, it was not possible to detect any effect of pressure on the thermal expansion coefficient from two types of experiments used. The data were normalized to $V/V_F = 1.0$ at $P_F = 22$ kbar, and fit to the Murnaghan equation $(P - P_F) = (B_F/B_{F'})(V_F/V)B_{F'}-1$, where for H_2O $B_F = 227$ and $B_{F'} = 5.3$, while for D_2O $B_F = 242$ and $B_{F'} = 4.6$ using a least-squares computer fit. It was concluded that D_2O seemed to be measurably more compressible than H_2O. (P.C.H.)

35798 FORCE CONSTANT DISPLAYS OF UNSYMMETRIC MOLECULAR ISOTOPES OF H_2O, H_2S, H_2Se, AND HCCH. Nibler, Joseph W.; Pimentel, George C. (Univ. of California, Berkeley). J. Mol. Spectrosc., 26: 294-314(July 1968).

The results of normal coordinate calculations can be presented in the form of "force constant displays," the loci of all possible solutions. The intersections of the loci for isotopically substituted molecules identify a "best" solution. The value of such displays is evaluated and demonstrated with the data for H_2O, H_2S, H_2Se, and HCCH. The displays derived from both experimental frequencies (ν's) and harmonic frequencies (ω_e's) are examined. In general, the partially deuterated, unsymmetric isotopic molecule is more useful in determining potential functions than is the completely deuterated species. The significance and relative effectiveness of various error-weighting functions in normal coordinate iterative programs are demonstrated. The displays generally determine the principal force constants to better than 5%, but the off diagonal force constants must be interpreted with care. (auth)

35799 INTERNAL ROTATION IN PROPARGYL ALCOHOL FROM MICROWAVE SPECTRUM. Hirota, Eizi (Tokyo Univ.). J. Mol. Spectrosc., 26: 335-50(July 1968).

The microwave spectrum of propargyl alcohol was observed for the normal species as well as a deuterated species $HC \equiv CCH_2OD$ to study the internal rotation of the hydroxyl group in the molecule. The a-type R-branches indicated that the stable form was gauche, while no lines due to the trans isomer were observed. In addition to the pure rotation spectrum simultaneous transitions of the overall and internal rotation were detected. The separation between the lowest two levels of the internal rotation was determined to be 21.49 cm^{-1} for the normal species and 7.14 cm^{-1} for the deuterated species. An analysis leads to the result that the potential function has a minimum at 121 ± 3°C from the trans position, a low hump of 90 ± 10 cm^{-1} at the cis and a much higher barrier of $(6 \pm 2) \times 10^2$ cm^{-1} at the trans. (auth)

35800 MICROWAVE SPECTRUM OF PROPYLENE. DIRECT DETERMINATION OF THE INTERNAL ROTATION SPLITTING FOR THE $CH_2DCH \equiv CH_2$ SPECIES. Hirota, Eizi; Hirooka, Tomohiko; Morino, Yonezo (Tokyo Univ.). J. Mol. Spectrosc., 26: 351-67(July 1968).

The microwave spectrum of a deuterated species of propylene, $CH_2DCH \equiv CH_2$, was investigated. Some of the 2 ← 1 transitions of the first-excited torsional state of the asymmetric form showed unusually large splittings and anomalous Stark effects. This observation was accounted for by an accidental degeneracy of the two J = 1 states, which were coupled by the tunnel effect and pushed away from each other. By analyzing the spectrum, the splitting due to the internal rotation was determined to be 19.3 and 768 to 795 Mc/sec for the ground and the first-excited states, respectively. (auth)

35801 NORMAL COORDINATE TREATMENT OF n-PROPANOL AND ITS DEUTERO ANALOG. Fukushima, Kunio; Zwolinski, Bruno J. (Texas A and M Univ., College Station). J. Mol. Spectrosc., 26: 368-83(July 1968).

Normal coordinate treatment of n-propanol and its deutero analog (n-C_3H_7OD) was carried out using the modified Urey-Bradley force field. The normal frequencies and potential energy distributions were calculated for rotational isomers having trans conformation around the bond, CH_2-CH_2, and the change of normal frequencies with the conformational change from trans to gauche around the bond was elucidated by calculation of normal frequencies of rotational isomers. On the basis of the calculated results, an assignment of vibrational spectra of n-propanol and its deutero analog is proposed. (auth)

35802 OXALYL HALIDES. ANALYSIS OF THE 3680 A ABSORPTION SYSTEM OF OXALYL CHLORIDE. Balfour, W. J.; King, G. W. (McMaster Univ., Hamilton, Ont.). J. Mol. Spectrosc., 26: 384-97(July 1968).

The vapor-phase absorption spectrum of oxalyl chloride in the 4000 to 3000 Å region was examined under high resolution. The bands are sharp in the region of the system origin, which is at 27 188.9 cm^{-1}, chlorine-isotope splittings being resolved. Excited state progressions in ν_7' (1460 cm^{-1}), ν_4' (398.5 cm^{-1}) and ν_8' (281.8 cm^{-1}) were identified; other assignments are $\nu_3' = 970$ cm^{-1} and $\nu_5' = 619.2$ cm^{-1}. For the ground state, $\nu_1'' - \nu_5''$ = 1783.3, 1217.1, 612.1, 498.5 and 283.0 cm^{-1}, respectively. Bands in which these totally-symmetric vibrations are excited are accompanied by sequences in +78 cm^{-1} (ν_7 sequence), −12 cm^{-1} (ν_{12} sequence), +32 cm^{-1} and −84 cm^{-1}, the latter sequences being tentatively identified as in ν_8 and ν_{11}, respectively. The band structure and intensity distribution are consistent with an allowed electronic transition from a planar trans ground state to a similar excited state in which r(C=O) has increased by ~0.08 Å, r(C−C) has decreased, and the C−C=O angle has opened slightly. The transition is identified as $\tilde{A}^1A_u - \tilde{X}^1A_g$ under the C_{2h} point group, the upper state resulting from $n \rightarrow \pi^*$ electron promotion. (auth)

35803 URANYL SULFATE ANION COMPLEXES IN NON-AQUEOUS SOLUTIONS. Vdovenko, V. M.; Skoblo, A. I.; Suglobov, D. N. Radiokhimiya, 10: 258-61(1968). (In Russian).

The composition and structure of the uranyl sulfate anion complexes formed in nonpolar solvents were examined by infrared spectroscopy. The results are shown graphically and in tabular form. (J.S.R.)

35804 COMPLEX FORMATION IN THE SYSTEM $UO_2^{2+}-H_2O_2-$EDTA$-H_2O$. Gurevich, A. M.; Polozhenskaya, L. P.; Solntseva, L. F. Radiokhimiya, 10: 195-202(1968). (In Russian).

In the investigation of equilibrium in the system $UO_2^{2+}-H_2O_2-$EDTA$-H_2O$ by light absorption and pH meter methods the formation of mixed complex ions $[(UO_2)_2(OO)Y]^{2-}$ and $[(UO_2)_2(OO)Y_2]^{6-}$ in weakly acid medium was found, (EDTA = H_4Y). The stability of the bonds of the peroxy group with the uranyl group in these compounds was evaluated. A scheme indicating the complicated mechanism of complex formation in the system $UO_2^{2+}-H_2O_2-$EDTA$-H_2O$ is proposed. (tr-auth)

35805 INVESTIGATION OF EQUILIBRIUM IN THE URANYL PEROXYCITRATE SYSTEM $UO_2^{2+}-H_2O_2-C_6H_5O_7^{3-}-H_2O$. Gurevich, A. M.; Osicheva, N. P. Radiokhimiya, 10: 202-10(1968). (In Russian).

The stability constant of the uranyl complex $[UO_2cit]^-$ was determined by direct and indirect methods. The reaction for the formation of the mixed peroxycitrate complex with uranyl was studied: monoperoxy-monocitrate diuranyl ion $[(UO_2)_2(OO)cit]^-$, diperoxy-monocitrate-diuranyl ion $[(UO_2)_2(OO)_2cit]^{3-}$, and diperoxy-monocitrate-monohydroxy-diuranyl ion $[(UO_2)_2(OO)_2(cit)(OH)]^{4-}$. The stability constants of some of these compounds were determined. The conversion of the mixed complex $[(UO_2)_2(OO)_2(cit)(OH)]^{4-}$ into the triperoxyuranyl ion $[UO_2(OO)_3]^{4-}$ takes place in the pH range from 9 to 12. A scheme indicating the mechanism of the complex formation in this system is proposed. Data on the evaluation of the stability constants of the triperoxy uranyl ion $UO_2(OO)_3^{4-}$ are given. The value of this constant ($\sim 5 \times 10^{27}$) made it possible to consider the uranyl peroxycomplexes thermodynamically much more stable than the uranyl carbonate complexes. (tr-auth)

35806 COMPLEX URANYL PEROXYFLUORIDE COMPOUNDS. II. INVESTIGATION OF THE EQUILIBRIUM IN THE SOLUTION. Gurevich, A. M.; Susorova, N. A. Radiokhimiya, 10: 211-21 (1968). (In Russian).

During the spectrophotometric investigation of the interaction of the uranyl fluoride complex $[UO_2F_4]^{2-}$ with hydrogen peroxide in solutions with uranyl concentration of 1×10^{-3} M and fluoride concentrations of ≥0.1M, a series of mixed peroxyfluoride complexes were identified: $[(UO_2)_2(OO)F_5]^{3-}$, $[(UO_2)_2(OO)_2F_5]^{5-}$, $[(UO_2)_2(OO)_2F_2]^{4-}$, and $[(UO_2)_2(OO)_3(OH)F_2]^{5-}$. The complex mechanism for the interaction of the uranyl fluoride complexes with H_2O_2 were examined. It was found that the formation of peroxyfluoride complexes takes place in the pH range from 5 to 9.5 and proceeds by progressive replacement of the fluoro group in the inner sphere of the complex on the peroxy group, which occurs in agreement with the high displacement capacity of the latter. The stability constants of the mixed peroxyfluoride complexes $[(UO_2)_2(OO)F_4]^{3-}$, $[(UO_2)_2(OO)_2F_5]^{5-}$, and $[(UO_2)_2(OO)_3F_2]^{4-}$ were calculated from the experimental data. It was found that the high stability of the mixed peroxyfluoride complexes is caused by the high stability of the

peroxy group bonds with the uranyl ions. An evaluation was made of the value of the stability constant of the triperoxyuranyl ion $[UO_2(OO)_3]^{4-}$. (tr-auth)

35807 TEMPERATURE OF MELTING AND VAPOR PRESSURE OF SATURATED NEPTUNIUM TETRACHLORIDE. Choporov, D. Ya.; Chudinov, E. G. Radiokhimiya, 10: 221-7(1968). (In Russian).

Knudsen's method was used for measuring the vapor pressure of UCl_4 and $NpCl_4$. It is found that for UCl_4, $\lg p = -10263/T + 13.253$ (in the temperature range from 279 to 423°C) and for $NpCl_4$ $\lg p = -9547/T + 12.904$ (in the same temperature range). The free energy variations during evaporation of UCl_4 and $NpCl_4$ are: $UCl_4: \Delta F = 58100 + 36.85\ T \lg T - 168.2\ T$ and $NpCl_4: \Delta F = 53156 + 36.85\ T \lg T - 164.1\ T$. The melting point of $NpCl_4$ was found to be 517.5 ± 2.5°C. (tr-auth)

35808 INVESTIGATION OF THE SYSTEM V_2O_5–UO_3. Efremova, O. A.; Gumerov, M. F.; Kovba, L. M. Radiokhimiya, 10: 228-33(1968). (In Russian).

A thermographic and x-ray study was made of the binary system $V_2O_5 - UO_3$. The existence of the compounds UV_2O_8 and $U_2V_2O_{11}$ in this system was found. The constitution diagram of the system was established for the composition range from 0 to 75 mole % UO_3. It was found that the natural binary system exists at the fusion temperature, but above the fusion temperature a loss of oxygen and a displacement of the condensed phase to the area of the composition of the ternary system U–V–O with a lower oxygen content occur. The absence of the compound $U_2V_6O_{21}$ in the $V_2O_5 - UO_3$ system and the presence of the compounds UV_3O_{10+x} in the region with reduced oxygen content were found. The results of x-ray diffraction studies and lattice parameter measurements on the compounds UV_3O_{10}, $UV_3O_{10.33}$, $U_2V_6O_{21} \cdot nH_2O$, and UV_3O_{10+x} are reported. The parameters of the elementary cell of UV_2O_8 and $U_2V_2O_{11}$ were determined. It was found that in the system V_2O_5–UO_3 the compound $(UO_2)_3(VO_4)_2$ does not exist. (tr-auth)

35809 SORPTION OF URANYL IONS ON ZIRCONIUM PHOSPHATES AT ELEVATED TEMPERATURES. Vesely, V.; Ruvarac, A.; Sedlakova, L. (Boris Kidric Inst. of Nuclear Sciences, Belgrade. Inst. of Nuclear Research, Rez, Czechoslovakia). J. Inorg. Nucl. Chem., 30: 1101-6(May 1968).

The stability of various zirconium phosphates ranging from granular amorphous to very good crystalline material was investigated for samples autoclaved at high temperatures in aqueous media. The semicrystalline and crystalline materials were stable under these conditions. The sorption of uranyl ions was investigated at different temperatures and the formation of $UO_2HPO_4 \cdot H_2O$ was proved by x-ray analysis following the sorption of uranyl ions on these materials under high temperature conditions. (auth)

35810 RUTHENIUM COMPLEXES WITH ETHYLENEDIAMINETETRAACETIC ACID. Scherzer, J.; Clapp, L. B. (Brown Univ., Providence). J. Inorg. Nucl. Chem., 30: 1107-9(May 1968).

The preparation of EDTA complexes of Ru directly from commercially available $RuCl_3$ and potassium hexachlororuthenate(IV) is described. The products varied according to reaction conditions, and included $Ru(H_2EDTA)Cl_2 \cdot H_2O$, $Ru(H_2EDTA)Cl$, $Ru(H_2EDTA)Cl \cdot H_2O$, $Ru(HEDTA) \cdot H_2O$, (NH_4) Ru $(EDTA) \cdot 2H_2O$, $Ru(H_2EDTA)Cl_2 \cdot 3H_2O$, and corresponding potassium and ammonium salts. Infrared spectra confirmed these formulations. It was concluded that although H_4EDTA can be used to complex Ru(III) and/or Ru(IV) ions, this reagent would not be satisfactory for the quantitative determination of Ru, since more than one product is formed. (UK)

35811 METHOD FOR PRODUCING URANIUM TETRAFLUORIDE. Vondra, Benedict L.; Ward, John A. Jr. (to Nuclear Materials and Equipment Corp.). U. S. Patent 3,382,049. May 7, 1968. Filed Jan. 27, 1965.

A method and apparatus are described for producing dense high-quality powdered UF_4 by the reaction of UF_6 with trichloroethylene. The C_2Cl_3H is cracked by removal of two F atoms from the UF_6 with with the formation of almost no free C. The reaction is carried out at a temperature of about –50°C with the C_2Cl_3H being supplied as a fog of particles having a diameter of about 20 to 30 μ. (B.L.M.)

35812 EFFECTS OF HEAT AND DEUTERIUM OXIDE ON DIVISION AND MACROMOLECULAR SYNTHESIS IN SYNCHRONIZED TETRAHYMENA PYRIFORMIS. Pennington, Carl James Jr. Amherst, Mass., Univ. of Massachusetts, 1967. 125p. Thesis.

Cells of Tetrahymena pyriformis GL were synchronized in a medium containing salts, 2% proteose-peptone, and 0.4% liver extract by means of a series of 7, 30-min shocks at 34°C alternated with 30-min periods at 28°C. Cells exposed to 34°C from the end of the synchronizing heat treatment (EH), that is, given a prolonged heat shock, would divide only in the presence of 15 to 40% D_2O added at EH, with 30% D_2O producing the best synchrony. Heat and D_2O applied at various times during the predivision period to cells maintained at 28°C prior to treatment, produced three main classes of cells, depending on the time of exposure: those exposed to 34°C and D_2O before 25 min past EH having their division maxima at 190 min; those exposed at or near 25 min showing virtually no division activity; and those exposed after 25 min having their division maxima at about 90 min past EH. Cells showing division activity in D_2O complete cytokinesis in only a small fraction of the cases with the remainder, "regressing," that is, obliterating their division furrows and becoming large, nondividing cells. A study of the macromolecular basis for these division effects utilizing both radioisotope labeling and chemical determinations showed that less RNA and DNA are made in the presence of D_2O compared to controls at 34°C. However, protein synthesis was not depressed and, in fact, the rate rises to a peak at about the time division activity first appears (140 to 160 min at 34°C in D_2O). Significantly, the total cellular protein, as determined by the Folin–Lowry method, becomes higher after 100 min. This rise in protein synthesis occurs after division-related RNA synthesis is complete (as shown by the loss of sensitivity of the cells to actinomycin D at 80 to 100 min past EH) and finishes at the time division-related protein synthesis is complete (as shown by the loss of sensitivity of the cells to cycloheximide at 160 min past EH). That D_2O is enhancing division-related protein synthesis is also shown by chromatographic fractionation of water-soluble proteins on DEAE-cellulose wherein fraction 7, shown by previous work to be correlated with division, is raised in amount in D_2O relative to a 34°C control. The results are interpreted on the basis of the assumption that D_2O permits the net synthesis of division-related RNA, presumably messenger, by one or more of the following alternatives: a selective stabilization of m-RNA synthesis; an inhibition of heat-induced release of ribonuclease as well as; an inhibition of ribonuclease activity; and an enhancement of formation of ribosomal subunits, allowing m-RNA transfer across the nuclear envelope. This last interpretation receives some support from the finding that heavier-than-ribosomal RNA shows evidence of piling up in 34°C cells, but not in cells at 34°C in the presence of D_2O. (Disser. Abstr.)

35813 THE DIFFUSION AND SOLUBILITY OF HYDROGEN AND DEUTERIUM IN NICKEL AND PLATINUM. Kass, William Joseph. Tempe, Ariz., Arizona State Univ., 1968. 158p. Thesis.

The diffusion coefficient and solubility of hydrogen and deuterium were measured in single crystal samples of nickel and platinum of high purity by the permeation time lag method. Solubility and diffusivity of hydrogen were also measured in a nickel–4% vanadium alloy. The results obtained for the diffusion coefficient (D) and solubility (L) of hydrogen are as follows: nickel (200 to 420°C), $D(cm^2/sec) = (5.22 \pm 0.18) \times 10^{-3} \cdot \exp[-(9.56 \pm 0.04)kcal/RT]$, L(g-atom/g-atom) = (3.26 ± 0.17) × $10^{-3} \cdot \exp[-(3.60 \pm$ kcal/RT]; nickel–4% vanadium (180 to 460°C), $D(cm^2/sec) = (7.1 \pm 0.4) \times 10^{-3} \cdot \exp[-(10.1 \pm 0.06)kcal/RT]$, $L(g\text{-atom/g-atom}) = (1.11 \pm 0.05) \times 10^{-3} \cdot \exp[-(2.09 \pm 0.05)kcal/RT]$; and, platinum (350 to 670°C), $D(cm^2/sec) = (4.2 \pm 1.2) \times 10^{-3} \cdot \exp[-(5.2 \pm 0.4)kcal/RT]$, $L(g\text{-atom/g-atom}) = (1.4 \pm 0.5) \times 10^{-3} \cdot \exp[-(12.2 \pm 0.4)kcal/RT]$. It was found that the ratio of hydrogen to deuterium solubility and diffusion coefficient was strongly dependent upon temperature. A theory for the isotope effect was developed using the approximation that the hydrogen (or deuterium) behaved as an independent oscillator in the metal lattice. The results of this theory show the difference between the heat of solution of hydrogen and deuterium and the difference between the activation energies for diffusion to be temperature dependent. The decrease in the heat of solution of hydrogen found for nickel–vanadium from that value found for nickel may be explained if it is assumed that bound electronic states are formed. (Disser. Abstr.)

35814 HYDROLYTIC BEHAVIOUR OF CONCENTRATED THORIUM NITRATE AND PERCHLORATE SOLUTIONS. Danesi, P. R.; Magini, M.; Margherita, S.; D'Alessandro, G. (CNEN, Rome). Energ. Nucl. (Milan), 15: 335-41(May 1968).

The hydrolysis of thorium was studied potentiometrically up to a 0.5 molar metal concentration. In order to detect the influence of the medium on the hydrolysis process, an inert supporting electrolyte ($NaClO_4$) and a complexing one ($NaNO_3$) were used. The data were analyzed both graphically and by computer, making use of the LETAGROPVRID program. The computer analysis, where no initial assumptions on the composition of the complexes are involved, proved to give a better interpretation of the experimental data than the graphical one. (auth)

35815 DEUTERIUM ISOTOPE EFFECTS IN MIGRATING METHYL GROUPS. LeFevre, Paul Henry. Seattle, Univ. of Washington, 1967. 89p.

Thesis.

The effect of D substitution in the methyl groups that migrate during reactions that involve molecular rearrangements was studied for two reactions. The first reaction studied was the conversion of 1,1-diphenyl-2-methyl-1,2-propanediol to 3,3-diphenyl-2-butanone in aqueous acid solution of sulfuric acid. The effect on the rate constants of substituting one and two trideuteriomethyl groups was studied. The effect on the product distribution of substituting one trideuteriomethyl group was examined to determine the relative migratory aptitudes of deuteriomethyl and natural methyl groups. It was found that natural methyl groups migrate 1.35 times as frequently as do the deuterated methyl groups. The effect of one deuteriomethyl group on the rate of the reaction (k_{CH_3}/k_{CD_3}) was found to be 1.06. By combining the migratory aptitude ratio with the rate ratio it was possible to calculate the isotope effect on the reaction involving only the migration of a deuteriomethyl group as well as the effect on the rate of a nonmigrating deuteriomethyl group. The effect on the migration (CH_3/CD_3) was found to be 1.24 while the effect of a nonmigrating deuteriomethyl group (CH_3/CD_3) was found to be 0.93. The observed isotope effect on the compound containing two deuteriomethyl groups (k_{CH_3}/k_{CD_3} = 1.18) served as a check on the calculated effects. That is, both effects are operating in this compound and the observed effect should be the product of the individual effects (1.15). The significant isotope effect observed on the rate of this reaction indicates that the methyl group is taking part in the rate determining step. ^{18}O experiments showed that the 1-hydroxy group was about 50% exchanged in 5 min under conditions where no rearrangement took place. This indicates that the reaction mechanism involves reversible formation of the classical carbonium ion $Ph_2\overset{\oplus}{C}C(OH)(CH_3)_2$ followed by the rate controlling step of methyl migration. The second reaction studied was the solvolysis of 3,3-dimethylbutyl-2-p-bromobenzenesulfonate. Rate constants for the solvolysis of both 3,3-dimethylbutyl-2-p-bromobenzenesulfonate and 3,3-dimethyl-H_3^4-butyl-4-H_3^4-2-p-bromo-benzenesulfonate were measured in "50%" ethanol and 95% trifluoroacetic acid. In "50%" ethanol, the kinetic isotope effect (k_H/k_D) was found to be 0.97 ± 0.02 and in 95% trifluoroacetic acid the effect was 0.96 ± 0.05. The inverse effect, not significantly different from 1.0, is in contrast with the significant positive isotope effect found in the rearrangement of 1,1-diphenyl-2-methyl-1,2-propanediol. The absence of a significant isotope effect establishes that the methyl group is not participating in the rate determining step either as a migrating agent or anchimerically assisting in the removal of the leaving group. (Disser Abstr.)

35816 ACIDITIES OF WEAK CARBON ACIDS. Kollmeyer, Willy Dietrich. Los Angeles, Univ. of California, 1967. 141p.

Thesis.

The syntheses of optically active 4-biphenylylmethoxyphenylmethane, VI-h, and 4-biphenylyldeuteriomethoxyphenylmethane, VI-d, are described. Isotopic exchange of (-)-VI-h in t-butyl alcohol-0-d catalyzed by potassium t-butoxide proceeded with net retention of configuration. The rate constants for exchange of (±)-VI-h and racemization of (+)-VI-d in the same medium were obtained. The variation with time of the optical activity of (-)-VI-h was also noted. These results were applied to a previously reported kinetic model for dissection of mechanistic pathways in base-catalyzed isotopic exchange reactions of optically active C acids. Use of the model revealed that exchange with retention was 33 times faster than exchange with inversion for (-)-VI-h in this medium. A kinetic substrate isotope effect for racemization of 2.7 at 116°C was determined. The predominant exchange with retention was interpreted in terms of intervening potassium carbanide ion-pairs which were asymmetrically solvated. Rate constants for isotopic exchange of triphenylmethane and diphenylmethane, and racemization of (-)-VI-h and (+)-VI-d in 75% methanol-0-d 25% dimethylsulfoxide-d_6 (percents by volume) catalyzed by potassium methoxide were measured. Unusual increases in the apparent kinetic molecularity of the catalyst and observed second order rate constants were noted as the catalyst concentration was raised. The rate data were correlated with the reported thermodynamic behavior of methanolic potassium methoxide solutions as measured by the acidity function, H_-. The theoretical basis and qualitative limitations of such rate correlations with H_- are discussed. In an alternative treatment the kinetic data were fitted to a rate equation of the form, rate = k_2 (RH)(B) + k_3 (RH)$(B)^2$, where RH is the substrate and B is the base catalyst. The two kinetic components were interpreted in terms of both free carbanions and potassium carbanide ion-pairs as reaction intermediates. Rate constants and activation parameters for isotopic exchange of fluorene, 9-phenylxanthene, 4-biphenylyldiphenylmethane, triphenylmethane, and diphenylmethane in 75% methanol-0-d 25% dimethylsulfoxide-d_6 (percents by volume) catalyzed by potassium methoxide were measured or calculated for 75°C. These kinetic acidities, which varied by a factor of about 10^7, were correlated with reported thermodynamic acid dissociation constants which varied by a factor of about 10^{10}. Substrate kinetic isotope effects for racemization of 2-(N,N-dimethylcarboxamido)-9-methylfluorene (estimated pK_a 20, k_H/k_D = 6.75 at 25°C) and VI(estimated pK_a 30, k_H/k_D = 2.5 at 126°C) in the above medium were also measured. The observed Bronsted relationship coupled with variation of the kinetic isotope effect and activation parameters with pK_a were interpreted in terms of rate-determining carbanion formation in these reactions. (Disser. Abstr.)

35817 CATALYTIC DEUTERIUM EXCHANGE REACTIONS WITH ORGANICS. XXXVIII. FURTHER STUDIES IN THE LABELING OF CYCLOOLEFINS WITH DEUTERIUM CHLORIDE. Calf, G. E.; Fisher, B. D.; Garnett, J. L. (Univ. of New South Wales, Kensington, Australia). Aust. J. Chem., 21: 947-60 (Apr. 1968).

A new method for labeling a wide range of cycloolefins (C_5 to C_{10}) with isotopic H is described. It consists of exchange with DCl or DBr in the presence of acetic acid at 130°C. The reaction is an addition-elimination process. Under certain conditions with some compounds, isomerization, rearrangement, and polymerization occur as side reactions. The advantages and limitations of the present method for labeling cycloolefins are discussed and compared with conventional procedures such as Wilzbach gas irradiation for tritium and metal-catalyzed exchange for both H isotopes. Possible mechanisms for the reaction are proposed. (BBB)

35818 HYDROGEN-DEUTERIUM EXCHANGE IN OVALBUMIN. Willumsen, Lars (Carlsberg Lab., Copenhagen). Compt. Rend. Trav. Lab. Carlsberg, 36: 247-63(1967).

The exchange reaction between peptide H atoms in ovalbumin and D atoms of heavy water solvent was studied by measuring the decrease of the amide II band absorption at 1535 cm^{-1}. Ovalbumin was found to have a large number of slowly exchanging peptide H's. Approximately 45% of the peptide hydrogens remained unexchanged after $2\frac{1}{2}$ yr at pH 6.3 and 21°. An increase in temperature from 21 to 35°C lead to a displacement of the pH profile between pH 2.8 and 4.8, corresponding to an additional exchange of about 12% of the peptide hydrogens of ovalbumin within $2\frac{1}{2}$ hr. An increase in temperature to 50 or 55°C caused a further exchange and a distinct alteration of the pH profile, the deuteration now being more extensive at pH 2.4 than at the isoionic point. Heating the sample to 65°C caused complete exchange of the peptide hydrogens in ovalbumin. The mechanism for the H exchange of ovalbumin could be described in a simple manner as dependent on hydroxyl ion concentration over the pH interval 6.3 to 10.5. The exchange at pH 4 to 5 was more complex and no definite explanation could be given. (BBB)

35819 CATALYTIC DEUTERIUM EXCHANGE REACTIONS WITH ORGANICS. XL. PYRIDINE, THE QUINOLINES, AZINES, AND ANILINE ON UNSUPPORTED GROUP VIII TRANSITION METALS. Calf, G. E.; Garnett, J. L.; Pickles, V. A. (Univ. of New South Wales, Kensington, Australia). Aust. J. Chem., 21: 961-72(Apr. 1968).

Pyridine, the quinolines, pyridazine, pyrimidine, pyrazine, s-triazine, and aniline exchanged with heavy water on the following Group VIII transition metals: Fe, Co, Ni, Os, Ru, Rh, Pd, Ir, and Pt. Three types of catalyst activation were used, including self-activation and hydrogen and sodium borohydride reduction of the inorganic salts. Platinum is the most useful catalyst for general exchange whereas Co possesses valuable specificity for selective α exchange in a large number of the heterocyclic compounds. A kinetic study of the deuteration of pyridine on Pt was performed. The exchange results were rationalized in terms of charge-transfer adsorbed intermediates. ESR was used to support this conclusion for the interaction between pyridine and potassium chloropalladite. π-Complex mechanisms were proposed to explain the observed deuteration behavior. (BBB)

35820 TRANSITION PROBABILITIES FOR THE IONIZATION OF N_2, O_2, NO, AND CO MOLECULES. Jain, D. C.; Sahni, R. C. (New York Univ., University Heights). Int. J. Quant. Chem., 2: 325-32(May 1968).

Franck-Condon factors are presented for the normal and stable isotope-labeled N_2, O_2, NO, and CO molecules for transitions to the observed ionized states by using the Rydberg-Klein-Rees (RKR) potential energy curves of the various electronic states involved. The isotopic molecules studied were $^{14}N^{15}N$, $^{16}O^{18}O$, $^{18}O_2$, $^{15}N^{16}O$, $^{14}N^{18}O$, $^{13}C^{16}O$, and $^{12}C^{18}O$. It was observed that for some transitions, the Franck-Condon factors based on the RKR potential energy curves differ appreciably from those based on the Morse potential function. The effect of isotopic substitution on the transition probabilities was also quite significant in some cases. (BBB)

35821 VIBRATIONAL SPECTRA OF THE HEXACHLORO-URANATE AND HEXACHLOROTHORATE IONS; UCl_6^{2-} AND $ThCl_6^{2-}$. Woodward, L. A.; Ware, M. J. (Oxford Univ.). Spectrochim. Acta, Part A, 24: 921-5 (July 1968).

Raman and infra-red spectra of UCl_6^{2-} and $ThCl_6^{2-}$ were obtained from methyl cyanide solutions of their alkylammonium or alkylphosphonium salts. The fundamentals are assigned in terms of the molecular point group O_h and their relation to vibrational progressions in the ultra-violet spectra is discussed. A force constant calculation indicates that UCl_6^{2-} and $ThCl_6^{2-}$ have M—Cl bonds significantly stronger than those of $PbCl_6^{2-}$. The influence on the vibrational spectra of the incomplete f-shell in UCl_6^{2-} is also noted and discussed. (auth) (UK)

35822 ION EXCHANGE STUDIES ON COMPLEX FORMATION. I. THORIUM–NITRATE SYSTEM. Tedesco, P. H.; de Rumi, V. B.; Gonzalez Quintana, J. A. (Facultad de Quimica y Farmacia, La Plata). J. Inorg. Nucl. Chem., 30: 987-94 (May 1968).

Cationic complex formation for the thorium nitrate system at ionic strength $\mu = 2\underline{M}$ was studied applying, with slight modifications, the Fronaeus's cationic exchange method (Acta. Chem. Scand., 5: 859(1951)). Stability constants, ligand numbers, and degree of formation of each complex were calculated. The values obtained for the stability constants were: $\beta_1 = 16.6 \pm 1\ \underline{M}^{-1}$, $\beta_2 = 34.0 \pm 12\ \underline{M}^{-2}$, $\beta_3 = 12.6 \pm 8\ \underline{M}^{-3}$. The stability constants are used to describe the composition of the solutions up to $[NO_3^-] = 0.5\ \underline{M}$. (auth) (UK)

35823 LOW TEMPERATURE THERMAL CHARACTERISTICS OF SOME INTERMETALLIC COMPOUNDS CONTAINING LANTHANIDES. Aoyagi, Masaya. Pittsburgh, Univ. of Pittsburgh, 1967. 95p.

Thesis.

A vacuum calorimeter with a completely automatic adiabatic shield control for the temperature range, 4 to 300°K, was produced. This involved the calibration of the working platinum resistance thermometers, the establishment of the best measuring conditions, and the writing of computer programs to evaluate the data. For temperatures below 10°K, a provisional scale was established and used. The over-all accuracy of the whole technique was verified by comparing the measurements on the heat capacity of pure benzoic acid with the corresponding data of the National Bureau of Standards (N.B.S.). No significant deviation from the data of N.B.S. was found. Heat capacity measurements were made on cubic Laves phase (1:2) compounds between nickel and lanthanides (specifically, cerium, praseodymium, and neodymium) and on rock-salt type (1:1) compounds between bismuth and lanthanides (specifically, lanthanum and praseodymium). For some of these materials and elemental praseodymium, the measurements were extended down to 1.6°K, using an electronic specific calorimeter. These results were used, in conjunction with magnetic data, to obtain entropies, crystal field splittings, and information about electronic status of lanthanides in these materials. A crystal field contribution to the heat capacity was observed for praseodymium–nickel (1:2), neodymium–nickel (1:2) and praseodymium–bismuth (1:1) compounds. The observed crystal field heat capacity anomaly for praseodymium–bismuth (1:1) was fitted reasonably well with an over-all splitting equal to 407°K, contrasted with 199°K deduced from magnetic measurements. For praseodymium–nickel (1:2), the difference in heat capacity between cerium–nickel (1:2) and praseodymium–nickel (1:2) taken to be crystal field heat capacity showed a maximum in the vicinity of 13°K. For neodymium–nickel (1:2), crystal field heat capacity was observed around 50°K, by subtracting away the heat capacity of cerium–nickel (1:2), indicating an over-all splitting of 431°K. Magnetic heat capacity anomaly was observed for neodymium–nickel (1:2) around 9.8°K with 75% of Rln2, the expected value of entropy. This discrepancy may be due to inadequacy of the blank substance, cerium–nickel (1:2), which showed anomalous behavior in the helium range. Various anomalies observed are discussed. (TSS) (Disser. Abstr.)

35824 SELF-DIFFUSION OF OXYGEN IN NEODYMIUM AND SAMARIUM SESQUIOXIDE. Stone, Glenn Duane. Tempe, Ariz., Arizona State Univ., 1968. 94p.

Thesis.

The oxygen diffusion coefficients have been measured for Nd_2O_3 (A-type) and Sm_2O_3 (B-type), and an estimate was made for Er_2O_3 at 1000°C. The method of isotope exchange between the solid and oxygen gas enriched with ^{18}O was used. The gas was analyzed with a mass spectrometer to determine the rate of change of ^{18}O due to the exchange. Sampling of the gas was done continually through a Granville-Phillips leak valve connected directly to the analyzer of the Consolidated Electrodynamic Corporation 21-130 mass spectrometer. An internal gas circulating pump was used to pass the gas over the sample and through the leak valve. Using a Control Data Corporation 3400 computer and the relations given by R. Haul, G. Dumbgen, and D. Just in 1962, this rate of change in the gas could be related to the diffusion coefficient, D, and a phase boundary reaction constant, K. The samples used were in the form of spheres prepared in an argon plasma. The diameters of the spheres were on the average 100 microns. Two samples of different purity were used for Sm_2O_3, 99.9% and 99.998%. The dependence of the diffusion coefficients with temperature from about 700 to 1000°C was determined as well as the pressure dependence from about 30 to 300 mm Hg. The diffusion coefficients expressed as a function of temperature were for the 99.9% Sm_2O_3 $D = 9.2 \times 10^{-8} \exp(-23.5 \pm 2$ kcal/RT), for the 99.998% Sm_2O_3 $D = 6.0 \times 10^{-6} \exp(-21.3 \pm 0.5$ kcal/RT), and for the 99.999% Nd_2O_3 $D = 1.3 \times 10^{-4} \exp(-31 \pm 2$ kcal/RT). The values of D at these temperatures compare favorably with those measured previously by other methods. (TSS) (Disser. Abstr.)

35825 ELECTRON-MICROSCOPE AND ELECTRON-GRAPHIC STUDIES OF ASH OF MIXED HEAVY METAL FERROCYANIDES. Skrylev, L. D.; Kalitina, L. N. (Ural Scientific Research Inst. of Chemistry, USSR). Zh. Prikl. Khim., 41: 929-32 (Apr. 1968). (In Russian).

Electron-microscope and electron-graphic studies of dispersion phases of potassium ferrocyanides mixed with Fe, Co, Zn, Ni, Cu, and uranyl ferrocyanides showed that the ash of the mixed heavy metal ferrocyanides examined are polydispersed. The size of the ash particles varies from 10^{-5} to 10^{-6} cm. The dispersed phase of the ash has a crystalline structure. (R.V.J.)

35826 CHANGES OF CERTAIN PHYSICO-CHEMICAL PROPERTIES IN ZrC–ZrN SYSTEMS. Vil'k, Yu. N.; Danisina, I. N.; Omel'chenko, Yu. A.; Ryzhkova, T. P. Zh. Prikl. Khim., 41: 918-21 (Apr. 1968). (In Russian).

The changes in lattice period, microhardness, x-ray, pycnometric densities, and molar mixing volumes as functions of the $ZrC_{0.938}$–$ZrN_{0.818}$ content in the phase diagram δ-region were studied at 2000 to 2600°C. At examined temperatures the alloy formed continuous solid solutions. (R.V.J.)

35827 THE 1:3 URANIUM(VI)–8-HYDROXYQUINOLINE COMPOUND: ITS COMPOSITION AND THERMAL CONVERSION INTO BIS(8-HYDROXYQUINOLINATO)DIOXOURANIUM(VI). Corsini, A.; Abraham, J. (McMaster Univ., Hamilton, Ont.). Talanta, 15: 562-5 (June 1968).

Evidence is provided to show that in the red compound formed between uranium(VI) and 8-hydroxyquinoline, the ligand-to-uranium ratio is slightly lower than 3:1 at least when the compound is prepared by a widely accepted procedure. Competition between 8-hydroxyquinoline and other ligands such as water or ammonia is probably responsible for the non-stoichiometry. Further, it was found that a procedure frequently used for the thermal conversion of the red compound into bis(8-hydroxyquinolinato)dioxouranium(VI) yields a compound in which the ligand-to-uranium ratio is less than 2:1. Conditions which lead to the thermal preparation of the stoichiometric bis compound are described. (auth) (UK)

Radiation and Nuclear Chemistry

Refer also to abstracts 35769, 36115, 36513, and 36516.

35828 (BNWL-SA-1841) NITROBENZENE RADICAL IONS AS INDICATORS FOR REDUCING SPECIES FORMED DURING RADIOLYSIS OF AMINO ACID SOLUTIONS. Diebel, R. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 4, 1968. Contract AT(45-1)-1830. 7p. (CONF-680608-4). Dep. CFSTI.

From American Chemical Society Meeting, Portland, Ore.

A method is presented for detecting the formation of radicals derived from solutes such as amino acids during gamma irradiation of aqueous solutions. In the indirect method used, the short-lived amino acid radicals reduce nitrobenzene to form the long-lived nitrobenzene radical ion. The nitrobenzene radical ion ESR spectrum can be eliminated by saturating the solution with nitrous oxide which results in removal of the hydrated electron through rapid reaction to form hydroxyl radicals. If the ESR signal also persists after saturating the solution with nitrous oxide, this indicates that the new reducing species has been produced by hydroxyl-radical attack on the solutes, i.e., amino acids, present with nitrobenzene. Results obtained with serine, alanine, valine, and methanol are presented. (P.C.H.)

35829 (CALT-383-5) MOLECULAR IONIZATION IN DENSE MEDIA. Final Technical Report. Robinson, G. Wilse (Cali-

fornia Inst. of Tech., Pasadena). June 17, 1968. Contract AT(04-3)-383. 11p. Dep. CFSTI.

Excitation transfer in organic crystals was studied. A theory of electronic energy relaxation in the solid phase was considered. Results indicated that in π-electron organic crystals the degree of triplet excitation migration is much greater than that for the singlet and that the interaction matrix element associated with the triplet may be of the same order as that for the lowest singlet. An empirical method by which the Franck-Condon factors may be ascertained from the electronic energy gaps in π-electron molecules was considered, and the results were used to estimate radiationless transition probabilities for a number of systems. Triplet-triplet annihilation in pure and mixed organic crystals was studied. The role of triplets in photosynthesis is considered. Spectra of excited molecules were observed. A general mechanism by which both symmetry-forbidden and multiplicity-forbidden transitions of a molecule in a perturbing environment could gain intensity is presented. (M.C.G.)

35830 (JINR-E7-3766) ELEMENT 103 OF THE PERIODIC SYSTEM. (Review Article). Donets, E. D.; Druin, V. A.; Mikheev, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 22p. Dep.

The results of work on the synthesis and the study of the properties of isotopes of element 103 are analyzed. It was concluded that the most reliable and complete data are available for the isotope $^{256}103$. The half-life of this isotope is about 35 sec and its alpha emission spectrum is complex and lies between 8.3 and 8.5 MeV. To get the same degree of unambiguity in determining the properties of other isotopes of 103, in particular of $^{257}103$, some additional experiments are needed. (19 references). (auth)

35831 (PRNC-116) MATRIX ISOLATION STUDIES OF THE GAMMA-RADIOLYSIS OF HETEROCYCLIC MOLECULES. Technical Progress Report No. 3. Grimison, A.; Simpson, G. A. (Puerto Rico Nuclear Center, San Juan). Apr. 1968. Contract AT(40-1)-1833. 57p. Dep. CFSTI.

Results are reported for studies on: absorption spectra of radiolytic intermediates at 77°K; luminescence of irradiated glassy solutions at 77°K; electron spin resonance of radiolytic intermediates at 77°K; photochemistry of aromatic amines and heterocyclic compounds at 77°K; molecular orbital calculations; valence bond calculations. Data on the irradiated organic compounds are tabulated. A paper on the spectrophotometric identification of gamma-radiolytic intermediates in a new halogenic glassy matrix is appended. The absorption spectra, dose dependence, and character of the intermediates produced by gamma radiolysis at 77°K of a 50-50 vol % mixture of Freon-11 (CCl_3F) and Freon-114B2 (CF_2BrCF_2Br) were determined. (P.C.H.)

35832 (UCRL-Trans-10244) STUDY OF THE PRECIPITATES OF METALLIC LITHIUM IN LITHIUM FLUORIDE AND LITHIUM HYDRIDE IRRADIATED WITH THERMAL NEUTRONS. Mazieres, Charles. Translated by I. M. R. Jones for Univ. of California Lawrence Radiation Lab., Livermore, from Ann. Chim. (Paris), 6: 613-21(1961). 18p. Dep. CFSTI.

Attempts were made to pinpoint the processes of melting and crystallization of metallic lithium agglomerations in neutron-irradiated lithium salts. It was concluded that freshly precipitated or slightly annealed agglomerations of lithium must present a continuous distribution of dimensions and degrees of crystal perfection. Therefore, there is probably no well-defined melting temperature, rather a melting range starting a few degrees below 180°C. Mechanisms of the transformation of fcc Li to bcc Li are considered. (M.C.G.)

35833 EFFECTS OF RADIATION ON STYRENE AND α-METHYL STYRENE IN AQUEOUS SOLUTION. A STUDY BY PULSE RADIOLYSIS. Schneider, Christel; Swallow, A. J. (Univ., Cologne. Holt Radium Inst., Manchester, Eng.). Makromol. Chem., 114: 172-81(1968).

Dilute aqueous solutions of styrene and α-methylstyrene were irradiated with 2 μsec pulses of 4-MeV electrons. The absorption spectra of transient species formed under irradiation were taken and kinetic studies on the decay of the absorptions were carried out. From the influence of various additives on the absorption spectra and from the kinetic data obtained it was concluded that the absorption at 345 mμ for styrene and at 350 mμ for α-methylstyrene is due to radicals formed by addition of OH· to the aromatic ring. The decay of the substituted hydroxycyclohexadienyl follows a second-order kinetics with a rate constant of $k \approx 10^9$ l · mole^{-1} sec^{-1}. The long-lived uv-absorption with maxima at 305 and 320 mμ is attributed to the polymerizing styrene radical with the structure of a substituted benzyl. Such radicals can be formed by electron attachment to the styrene followed by rapid protonation, and by addition of H· and OH· to the vinyl double bond. (auth)

35834 EFFECTS OF RADIATION ON STYRENE AND α-METHYL STYRENE IN DIFFERENT ORGANIC SOLVENTS AND IN THE PURE STATE. A STUDY BY PULSE RADIOLYSIS. Schneider, Christel; Swallow, A. J. (Univ., Cologne. Holt Radium Inst., Manchester, Eng.). Makromol. Chem., 114: 155-71 (1968).

Styrene and α-methylstyrene, both in solution in organic solvents and in the pure state, were subjected to 2-μsec pulses of 4-MeV electrons. The absorption spectra of the transient intermediates formed were measured and kinetic studies were carried out. The results for styrene were similar to those for α-methylstyrene. In the case of solutions of styrene in cyclohexane, transients absorbing at 320 and 390 mμ were seen. The absorption at 320 mμ is attributed in part to a slowly disappearing polymer radical with a structure resembling benzyl. The absorption at 390 mμ disappears rapidly and is attributed to a radical anion. Various additives interfere with its formation. The effect of styrene concentration and dose rate on the formation of the transients is reported. Styrene reacts rapidly with solvated electrons in methanol, but the anion formed becomes protonated rapidly. In benzene the absorption appears at a wavelength similar to that seen with pure benzene. Intense absorptions at 290 and 320 mμ are seen in carbon tetrachloride solution. Absorptions at ~320 and ~400 mμ are seen when pure styrene or α-methylstyrene are pulsed. A stable species absorbing at 320 mμ is also present. Values for rate constants are compared with those obtained from measurements of polymer formation. (auth)

35835 INFLUENCE OF NITRIC OXIDE ON THE RADIOLYSIS OF LIQUID AND GASEOUS CYCLOHEXANE. I. SECONDARY REACTIONS IN THE RADIOLYSIS OF LIQUID AND GASEOUS CYCLOHEXANE IN THE PRESENCE OF NO. Milhaud, Jeannine (Laboratoire de Physico-Chimie des Rayonnements, Oray, France). J. Chim. Phys., 65: 786-95(May 1968). (In French).

The secondary reactions of nitroso compounds RNO arising from the scavenging by NO of free radicals issued from the radiolysis vary according to the physical state and the nature of the medium where they have been formed. In liquid cyclohexane, these compounds react with NO to form the complexes $[RNO(NO)_2]$ which decompose to give molecular products. On the other hand, in gaseous cyclohexane, the complexes decompose by a radical step leading to a chain process formation of nitrogen; furthermore, a heterogeneous isomerization of RNO to the non-reactive oxime R'CH=NOH overbalances the formation of the complexes for NO concentrations smaller than 10^{-3} mole/l. (auth)

35836 INFLUENCE OF NITRIC OXIDE ON THE RADIOLYSIS OF LIQUID AND GASEOUS CYCLOHEXANE. II. STUDY OF THE RADIOLYSIS OF GASEOUS CYCLOHEXANE. Milhaud, Jeannine (Laboratoire de Physico-Chimie des Rayonnements, Orsay, France). J. Chim. Phys., 65: 796-804(May 1968). (In French).

From the analysis of products arising from the radiolysis of C_6H_{12} and mixtures $C_6H_{12} + C_6D_{12}$, using NO as a radical scavenger, the primary yields of the various radical and ionic species were calculated and the occurrence of ionic chain reactions isotopic exchange between C_6H_{12} and C_6D_{12} is stated. The results of an independent study by mass spectrometry of the ion-molecule reactions in cyclohexane agree with those of radiolysis in showing that the only secondary ions are $C_6H_{11}^+$ and $C_6H_{10}^+$ arising from H^- and H_2^- transfer reactions from cyclohexane to various primary ions. (auth)

35837 DEISTVIE IZLUCHENII NA NEORGANICHESKIE STEKLA. (Radiation Effects on Inorganic Glass). Byurganovskaya, G. V.; Vargin, V. V.; Leko, N. A.; Orlov, N. F. Moscow, Atomizdat, 1968. 244p.

A brief review is given on radiation effects on matter. Radiation effects on silicate, borate, and phosphate glass are discussed considering radioinduced coloration, radio- and thermoluminescence, and changes of physicochemical properties. Radiation resistance of various vitreous materials and various types of vitreous-material dosimeters and detectors are reviewed. Certain aspects of structural defects are analyzed. (408 references.) (R.V.J.)

35838 ELECTRON SPIN RESONANCE OF A GAMMA-IRRADIATED SINGLE CRYSTAL OF 5-NITRO-6-METHYLURACIL. Snipes, Wallace; Benson, Brent (Pennsylvania State Univ., University Park). Contracts AT(30-1)-3799; NsG-324. J. Chem. Phys., 48: 4666-70(May 15, 1968).

Free radicals in gamma-irradiated 5-nitro-6-methyluracil have the unpaired electron localized on $C_{(4)}$ and $C_{(6)}$ of the pyrimidine ring. Principal values for the spectroscopic splitting factor are $g_u = 2.002$, $g_v = 2.005$, and $g_w = 2.008$. Hyperfine interaction between the spin density at $C_{(6)}$ and the methyl protons is nearly

axially symmetric with principal values $A_{\parallel}^{CH_3} = 10.7$ G and $A_{\perp}^{CH_3} = 8.8$ G. Hyperfine interaction between the spin density at $C_{(4)}$ and the hydroxyl proton has approximate principal values of $A_{\parallel}^{OH} = 9.5$ G and $A_{\perp}^{OH} = -0.5$ G. The unpaired spin densities are 0.32 on $C_{(6)}$ and 0.63 on $C_{(4)}$. The localization of spin density on $C_{(4)}$ and $C_{(6)}$ is unusual by comparison to the radicals in most other pyrimidines where the spin density is on $C_{(5)}$. (auth)

35839 ELECTRON SPIN RESONANCE STUDY OF γ-IRRADIATED SINGLE CRYSTALS OF SEMICARBAZIDE HYDROCHLORIDE. Shrivastava, Keshav N.; Anderson, Roy S. (Clark Univ., Worcester, Mass.). J. Chem. Phys., 48: 4599-4604 (May 15, 1968).

Electron spin resonance studies of γ-irradiated single crystals of semicarbazide hydrochloride and the deuterated form, $ND_2CONHND_3^+ \cdot Cl^-$, revealed the presence of the stably trapped $\cdot N_{(\alpha)}H_{(\alpha)} - N_{(\beta)}H_{(\beta)}^+$ radical obtained by C—N bond rupture of the parent molecule. The principal g values were $g_{aa} = 2.0041 \pm 0.0003$, $g_{bb} = 2.0023$, and $g_{cc} = 2.0044$. The principal elements of the hyperfine couplings were found to be $N_{(\alpha)} = 4.8 \pm 4.0$, 34.2 ± 1.0, and 11.8 ± 4.0 G; $H_{(\alpha)} = -10.5 \pm 4.0$, -27.6 ± 1.0, and -36.7 ± 4.0 G; $N_{(\beta)} = -4$ G; $H_{(\beta)} = 15 \pm 0.5$ G. The $N_{(\beta)}$ coupling was estimated from the angular dependence of the linewidths. The direction cosines of the $N_{(\alpha)}$ and $H_{(\alpha)}$ couplings were evaluated with reference to the orthorhombic crystallographic axes (a, b, c). The direction cosines of the N—H bond calculated from the ESR spectra were found to agree with those obtained by x-ray diffraction. The spin densities calculated for this radical indicate that the unpaired electron is highly localized on the α nitrogen, there being a spin density of 0.51 in the $2p\pi$ orbital of the α nitrogen. (auth)

35840 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XXII. POST-POLYMERIZATION OF VINYLENE CARBONATE. Hardy, Gy.; Nyitrai, K.; Nagy, G.; Ero, J.; Kisbenyi, M. (Polytechnical Univ., Budapest). Acta Chim. Acad. Sci. Hung., 56: 61-6(1968).

The ESR spectra of the products formed by the irradiation of vinylene–carbonate at low temperatures, the change of the concentration of radicals with rising temperature, and the ESR spectrum of the radical detectable in the system undergoing post-polymerization, have been studied. The latter spectrum significantly differs from the spectra of the primary irradiation products. The concentration of radicals, the kinetics of post-polymerization, and the change of the molecular weight of the polymers formed, unequivocally suggest that the post-polymerization of vinylene carbonate in the solid state is a radical process, and that at the conversion values attainable in such polymerization, vinylene carbonate behaves in a manner characteristic of monomers that polymerize within the crystal lattice. (auth)

35841 KINETICS OF THE SOLID STATE POLYMERIZATION OF N-VINYLCARBAZOLE. Tuedos, F.; Boros-Gyevi, E. (Central Research Inst. for Chemistry, Budapest). Acta Chim. Acad. Sci. Hung., 56: 67-85(1968).

The polymerization of N-vinylcarbazole initiated by γ radiation and azo-bis-isobutyronitrile, respectively, has been investigated. It has been found that the rate of the process may be described by the following autocatalytic equation: $(dx/dt) = KIt\, x^{1.2}\, (1-x)^2$, where $x = \xi/\xi_\infty$ and ξ denotes the conversion. The polymerization degree changes according to a maximum curve and depends on the conversion in the following manner: $\bar{P}(x) = P_0 x^\beta\, (1-x)$ where $\beta = 0.2 \pm 0.1$. Thus the rate of initiation can be given as follows: $W_i = (KIt/P_0)\, x\, (1-x)$. The elementary processes of the polymerization are discussed in detail. Initiation and chain growth take place at the interface of the polymeric and monomeric phases, while chain termination most probably occurs by the "burial" mechanism. According to the results obtained with chemical initiation, polymerization kinetics and polymerization degree essentially agree with the observations made with radiation initiation. In the light of these facts the solid state polymerization of N-vinylcarbazole seems to be a radical process. (auth)

35842 METHOD FOR POLYMERIZING VINYL MONOMER BY PRE-IRRADIATION. Okamura, Seizo (to Japanese Assn. for Radiation Research on Polymers). Japanese Patent 1967-15605. Aug. 29, 1967. Filed Sept. 2, 1960.

The method proposed has the following advantages: increased efficiency in the use of a radiation source, and hence, reduced cost of the irradiation; and, efficient polymerization even with a high dose-rate accelerator. A vinyl monomer in the liquid phase is irradiated with an ionizing radiation, either in air or oxygen. Then, outside of the irradiation room, it is heated or a reducing agent is added to it, to obtain the polymerization. (NSA of Japan)

35843 METHOD FOR GRAFT-POLYMERIZING ACRYLONITRILE ONTO POLYPROPYLENE FIBER. Tomioka, Kenji (to Toyo Rayon Co., Ltd.). Japanese Patent 1967-18329. Sept. 21, 1967. Filed Apr. 27, 1964.

The method proposed has the following advantages: increase in the grafting rate, its easy and economical control, and the technique is applicable for industrial production. Before or after the irradiation of polypropylene fiber with ionizing radiation to 0.1 to 10 MRAD, moisture in a weight ratio of 20 to 300% is attached to the fiber, to cover the surface with water film. Then, the fiber is placed in contact with vapor containing acrylonitrile, at 40 to 100°C. (NSA of Japan)

35844 RADIOLYSIS OF ALIPHATIC AND ALICYCLIC HYDROCARBONS. Freeman, Gordon R. (Univ. of Alberta, Edmonton). Radiat. Res. Rev., 1: 1-74(Mar. 1968).

The main types of reactions that appear to occur during the radiolysis of aliphatic and alicyclic hydrocarbons are reviewed, with 320 references. The radiolyses of unsaturated hydrocarbons have received relatively little attention, so relatively little is known about their radiolytic reactions. Discussion of the radiolysis of hydrocarbons is presented on the basis of gas, liquid, and solid phases. Some of the differences in reaction kinetics observed from one phase to another can be attributed to the different spacial distributions of the reactive species in the 3 phases. The spacial distribution of reactive species is mentioned separately in the discussion of each phase. Reaction kinetics are different in the solid phase from that observed in the liquid-phase radiolysis. Gas phase reactions are discussed in terms of reactive intermediates and their reactions (positive ions, electrons and negative ions, excited molecules, natural free radicals, effects of high pressure or gas density, and effect of electric field) for saturated and unsaturated hydrocarbons. Radioinduced conductance and nonhomogeneous kinetics of the ion reactions are considered in liquid-phase reactions. (BBB)

35845 METHOD FOR PRODUCING POLYOXYMETHYLENE COPOLYMER. Ishida, Shinichi (to Asahi Chemical Industries Co., Ltd.). Japanese Patent 1967-15629. Aug. 29, 1967. Filed Dec. 28, 1963.

By the method proposed, polyoxymethylene copolymer, having high thermal stability and good whiteness, can be obtained. Trioxane is polymerized by irradiation with an ionizing radiation in the presence of a small amount of itaconic acid anhydride, to give the polyoxymethylene copolymer. (NSA of Japan)

35846 METHOD FOR COPOLYMERIZING ETHYLENE AND VINYL ACETATE. Tsuda, Teizo (to Toyo Rayon Co., Ltd.). Japanese Patent 1967-15608. Aug. 29, 1967. Filed Dec. 2, 1963.

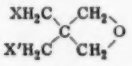
A method, employing irradiation, is proposed for copolymerizing ethylene and vinyl acetate. Ethylene and vinyl acetate are dissolved in an organic solvent, containing oxygen and the solution is irradiated with an ionizing radiation. (NSA of Japan)

35847 GROWTH AND DECAY OF PARAMAGNETIC SPECIES IN IRRADIATED POLY(METHYL METHACRYLATE). Lefebvre, Roland; (CNRS, Orsay, France); Maruani, Jean; Breheret, Emilienne; Coelho, Roland. Compt. Rend., Ser. C., 266: 1567-70 (May 27, 1968). (In French).

Studies were made on the growth, decay, and transformation of paramagnetic species in glassy poly(methyl methacrylate) during and after x irradiation. The presence of "peroxyl" (peroxide) radicals was observed in weak doses, but the usual kinetics seemed inadequate for explaining the evolution of these radicals. (tr-auth)

35848 METHOD FOR POLYMERIZING OXETANES WITH IONIZING RADIATION. Fukui, Kenichi (to Sumitomo Atomic Energy Industries, Ltd.). Japanese Patent 1967-17502. Sept. 13, 1967. Filed Mar. 11, 1964.

3,3-disubstituted oxetane, expressed by the general formula



(where X and X′ represent H, halogen, alkoxy group, or phenoxy group), is irradiated by ionizing radiation, in the presence of one or more simple metals in Group I and II (of the periodic table), and SrO, BaO, ZrO, and $UO_2(NO_3)_2$. (NSA of Japan)

35849 METHOD FOR SIMULTANEOUSLY PRODUCING ETHYL CHLORIDE AND n-BUTYL CHLORIDE. Hirayama, Tatsu (to Showa Denko K.K.). Japanese Patent 1967-19563. Oct. 2, 1967. Filed Mar. 8, 1965.

By the method proposed, employing ionizing radiation, ethyl

chloride and n-butyl chloride can be simultaneously produced with high efficiency; further, by adjusting the reaction conditions, the ratio of the yields of the two can be easily varied. For the simultaneous production of ethyl chloride and n-butyl chloride, ethylene and hydrogen chloride are allowed to react at a temperature from 0 to 70°C and a pressure from 1 to 200 atm, while irradiated with ionizing radiation at 10^5 to 10^7 R/h. (NSA of Japan)

35850 RADIOLYSIS OF HYDROGEN CYANIDE IN AQUEOUS SYSTEM. PART I. ESTIMATION OF RADIOLYTIC YIELD OF HYDROGEN CYANIDE AND PRODUCT INVESTIGATION. Ogura, Hajime (Tokyo Metropolitan Univ.). J. Radiat. Res., 8: 93-9 (Sept.-Dec. 1967).

The radiolysis of hydrogen cyanide was studied to elucidate the chemical action of ionizing radiation on a simple compound which is of interest in primordial organic chemistry. G (-HCN) was found to increase with increasing hydrogen cyanide concentration tending to 8 to 9 at 0.1 M in either air-free or aerated system, however the presence of oxygen reduced G (-HCN) very effectively at lower concentration. The limiting value in G (-HCN) when all the free radicals produced by water radiolysis were assumed to react with hydrogen cyanide was obtained as 5.9. This is in close agreement with well established values in radical yield in water and indicates the participation of these radicals in radiolysis of hydrogen cyanide at low concentration. High G (-HCN) at higher concentration was too large to be accounted for in this way and some other effect principally like polymerization of hydrogen cyanide must contribute to the increase in radiolytic yield. At high concentration of hydrogen cyanide, an absorption band at 295 mμ appeared, which was assigned to HCN tetramer by comparing with the absorption curve of tetramer extracted from azulmic acid prepared from hydrogen cyanide and triethylamine. Ammonia, carbon dioxide, and hydrogen were observed as radiolysis products. (auth)

35851 RADIOLYSIS IN THE ADSORBED STATE. II. N_2O ADSORBED ON SILICA GEL AND ZIRCONIA. Sagert, N. H.; Robinson, R. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 46: 2075-80(June 15, 1968). (AECL-3097).

The ^{60}Co γ radiolysis of N_2O adsorbed on silica gel and zirconia was studied. In both systems a large fraction of the energy absorbed in the solid is able to cause decomposition of the N_2O. For the silica gel-N_2O system, studies with electron scavengers have shown that on gels degassed at low temperatures, electrons are precursors for a large fraction of the yield and about 1 G unit of nitrogen is produced by other processes. The total nitrogen yield is smaller for gels degassed at high temperatures, but the yield of nitrogen produced by direct excitation stays constant at 1 G unit. Experiments using electron scavengers with the zirconia-N_2O system showed that direct excitation of the solid is responsible for most of the nitrogen yield at 7 G units on high surface zirconia. Studies of nitrogen yields on a number of zirconias showed that the range over which energy is transferred is about 50 Å. (auth) (Canada)

35852 RADIOLYSIS OF METHYLCYCLOPENTANE. II. EFFECTS OF BENZENE AND 1,3-CYCLOHEXADIENE IN THE LIQUID PHASE. Stover, E. Diane; Freeman, G. R. (Univ. of Alberta, Edmonton). Can. J. Chem., 46: 2109-14(June 15, 1968).

The inhibiting effects of benzene and of 1,3-cyclohexadiene (CHD) on the formation of hydrogen during the radiolysis of methylcyclopentane (MCP) were analyzed according to the nonhomogeneous kinetics of charge scavenging. The results are consistent with the following suggestions: CHD is an efficient scavenger of electrons; benzene is not an efficient scavenger of electrons but it may scavenge positive ions. These reactions offer alternatives to the hydrogen atom scavenging mechanism that has often been postulated in the past. They can decrease the hydrogen yield from MCP by 2.0 g units (based upon the energy absorbed only in MCP). In addition to the above scavenging mechanisms, which occur at relatively low solute concentrations (~1 mole %), benzene and CHD can each take part in a less efficient hydrogen inhibition reaction that can decrease $g(H_2)$ by another 1.6 units. This confirms the earlier suggestion that two different, inhibitable hydrogen forming processes occur during the radiolysis of saturated hydrocarbons. The yields of other products are also reported. (auth) (Canada)

35853 THE X-RADIOLYSIS OF WATER VAPOR CONTAINING METHANOL. EFFECTS OF SOME ELECTRON AND HYDROGEN ATOM SCAVENGERS. Dixon, R. S.; Bailey, M. G. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Can. J. Chem., 46: 1957-64 (June 15, 1968). (AECL-3098).

The x-radiolysis of water vapor containing methanol at 125°C and 1 atm pressure was studied alone and in the presence of some electron and hydrogen atom scavengers. In water vapor containing methanol only, a plateau value $G(H_2) = 7.9 \pm 0.3$ was obtained at all methanol concentrations above 0.5 mole %. Addition of propylene drastically reduces this yield due to efficient scavenging of hydrogen atoms, and values for the total number of H atoms from all precursors $g(H)_t = 7.5 \pm 0.2$ and $k(H + C_3H_6)/k(H + CH_3OH) \simeq 1600$ are deduced from the competition. An unscavengeable hydrogen yield $g(H_2) \sim 0.5$ is also indicated in mixtures containing propylene. Nitrous oxide and sulfur hexafluoride were found to scavenge electrons efficiently in water vapor containing methanol and the number of hydrogen atoms arising from electron-positive ion recombination is estimated to have a value $G = 2.2 \pm 0.6$. The number of hydrogen atoms arising from processes not involving electrons is $g(H) = 5.2 \pm 0.3$. Carbon tetrachloride reacts efficiently with both electrons and hydrogen atoms, with $k(H + CH_3OH)/k(H + CCl_4) = 0.085$. Values of $g(H) = 4.9 \pm 0.5$ and $g(H_2) = 0.8 \pm 0.2$ are deduced from mixtures containing carbon tetrachloride. (auth) (Canada)

35854 SYNTHESIS OF TRANSURANIUM ELEMENTS. Flerov, G. N.; Zvara, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Sci. J., 4: 63-9(July 1968).

It is stated that element 105 is currently being synthesized in the Soviet Union. Following this it should be possible to obtain a few atoms of element 106. All heavier elements appear to be too unstable to synthesize, except possibly number 114 or 126. (auth) (UK)

35855 METHOD FOR STABILIZING POLYOXYMETHYLENE. (to Japan Atomic Energy Research Inst.). British Patent 1,115,539. May 29, 1968. Priority date May 21, 1966, Japan.

A method of stabilizing highly crystalline polyoxymethylene of high molecular weight by reacting it with acetic anhydride in a heterogeneous reaction system by means of ionizing radiation at a temperature of about 100 to 150°C is described. The reaction is catalyzed by a small amount of pyridine, and the dose of ionizing radiation is between 2×10^5 and 2×10^6 R. (B.L.M.)

35856 ENERGY TRANSFER AND RADIATION PROTECTION IN THE RADIOLYSIS OF POLY(METHYLMETHACRYLATE) STEREOISOMERS AND COPOLYMERS. Henry, George Arthur. Chicago, Illinois Inst. of Tech., 1967. 126p.
Thesis.

Electron and ultraviolet irradiation of poly(methylmethacrylate) containing different additives and of syndiotactic and isotactic polymethylmethacrylate were carried out. The object of the study was to see whether protection of the poly(methylmethacrylate) by energy transfer to the additives (e.g., cumene and α-methylstyrene) occurred, and whether either intermolecular or intramolecular energy transfer was the dominant mode in these systems. In addition the effect of irradiation on mixtures of isotactic and syndiotactic poly(methylmethacrylate) was investigated. A mathematical treatment involving the use of Markov chain theory was used to explain the results. The electron irradiations were carried out with 13-MeV electrons from a linear accelerator. Thin films of polymer samples were irradiated with 2537 Å uv light. The degradation of the polymers was followed by the change in molecular weight as measured by viscometry of dilute solutions in benzene. Results indicate that isotactic poly(methylmethacrylate) is more stable to electron and uv irradiation than syndiotactic poly(methylmethacrylate). Mixtures of these stereoisomers formed by dissolving the polymers in methylene chloride when irradiated (as thin films), with uv light, displayed enhanced stability in the region of 30 to 50 wt % isotactic isomer. This is probably due to the formation of a stable complex between the stereoisomers. For the case of electron irradiation of polymethylmethacrylate containing cumene and α-methyl styrene the mathematical treatment shows that energy transfer to the sinks is from 20 to 40 times more probable than internal conversion. For uv irradiation, energy transfer to the sinks is five times as probable. In addition energy migration is primarily intramolecular. The Markov chain treatment also shows that the energy transfers by a series of random jumps. (Diss. Abstr.)

35857 PRODUCTION OF HIGH PURITY RADIOACTIVE ISOTOPES. Lieberman, Ephraim; Gemill, Wayne J. (to Union Carbide Corp.). U. S. Patent 3,382,152. May 7, 1968. Filed Sept. 28, 1964.

A process for the production of ^{99m}Tc comprises irradiating a base-soluble Mo containing material in a neutron flux until the desired amount of ^{99}Mo activity is formed, dissolving the irradiated Mo-containing material, containing the ^{99}Mo, in a base, adjusting the pH of the solution to be acidic and above pH 2.5, contacting an inorganic anion exchange material with the Mo-containing solution to load the Mo on the exchange material, and extracting the ^{99m}Tc, formed by the radioactive decay of the ^{99}Mo, from the loaded anion exchanger with an acid. (USAEC)

35858 RADIATION MODIFICATION OF WOOD. II. POPLAR WOOD IMPREGNATION WITH VINYL MONOMERS. Varga, Stefan; Rasztokay, Gustav (Bratislava Polytechnic Inst.). Jad. Energ., 14: 142-5(Apr. 1968). (In Czech).

Kinetics of vacuum-atmospheric radioinduced impregnation of wood pulp by styrene, acrylonitrile, and methyl methacrylate were studied. The total amount of the monomer and its space macrodistribution were determined by spectrophotometry, suspension, and gas chromatography. (tr-auth)

35859 RADIATION GRAFTING OF VINYL MONOMERS TO WOOL. III. LOCATION OF THE GRAFTED POLYMER. Ingram, P. (Research Triangle Inst., Research Triangle Park, N. C.); Williams, J. L.; Stannett, V.; Andrews, M. W. J. Polym. Sci., Part A-1, 6: 1895-1912(July 1968).

Electron microscopy and low-angle x-ray diffraction studies were used to determine the location of grafted polystyrene in wool. Samples grafted from 15 to 800% (dry weight increase) all exhibit a large increase in contrast in the cell membranes (IR) and nuclear-remnant regions (NR) in the electron micrographs. This is considered to be due in part to an unevenness in mechanical response to sectioning and in part to the deposition of ungrafted homopolymer in IR and NR, particularly at grafts of greater than about 100%. Analysis of the change in the 83 A equatorial x-ray reflection suggests that most of the grafted polymer resides in the keratinous matrix regions between the microfibrils within the cortical cells. At larger grafts the wool still retains its basic histological character, but the increase in this spacing is no longer proportional to the amount of graft, and the deposition of polymer becomes very inhomogeneous. (auth)

35860 METHOD FOR PRODUCING HIGH-QUALITY MOLDINGS OF RESINS OF THE POLYVINYL CHLORIDE SYSTEM. Yoshitake, Toshihiko (to Kurashiki Rayon Co., Ltd.). Japanese Patent 1967-25301. Dec. 4, 1967. Filed Oct. 26, 1964.

A method for producing high-quality moldings having high impact strength, cold resistance, and easy kneading includes irradiating a powdered resin of poly(vinyl chloride) with ionizing radiation. The irradiated powder is contacted with an unsaturated compound of the diene system (or its solvent solution) so as not to destroy the powder form, or the two are irradiated together. The product, containing 2 to 30% grafted polymer, is kneaded and molded into the desired shape. (NSA of Japan)

35861 METHOD FOR PRODUCING MOLDINGS OF IMPROVED RESINS OF THE POLYVINYL CHLORIDE SYSTEM. Yoshitake, Toshihiko (to Kurashiki Rayon Co., Ltd.). Japanese Patent 1967-25302. Dec. 4, 1967. Filed Oct. 26, 1964.

A resin of the polyvinyl chloride system, in the form of powder, is irradiated with ionizing radiation. To this is contacted, so as not to destroy the powder form, a mixed monomer (or its solvent solution) of 1 to 70 wt % of a styrene-system monomer and 99 to 30 wt % of a diene-system unsaturated compound. Or, the above two are irradiated while in contact with each other. The product, thus obtained, containing 2 to 30% of grafted portion, is kneaded and molded into a desired shape. (NSA of Japan)

35862 LOW CONVERSION RADIOLYSIS OF METHANE CONTAINING TRACES OF OXYGEN AND OLEFINS. Myers, Dale Carter. Lafayette, Ind., Purdue Univ., 1967. 160p.

Thesis.

A study has been made of the effects of traces of oxygen (<0.1 vol %) on the low conversion radiolysis of methane, and of methane containing traces of olefins (~0.1 vol %). Oxygen was consumed at a rate that was linear with absorbed dose. The minimum dose (ev/molecule) necessary for complete oxygen removal was: $D \simeq [O_2] \times 1.3 \times 10^{-5}$, where $[O_2]$ is in ppM. The protection, by oxygen, of ethylene and acetylene formed during radiolysis allowed the determination of $G(C_2H_4) = 0.624 \pm 0.021$ and $G(C_2H_2) \simeq 0.045 - 0.060$. Oxygen, when present in concentrations as low as 10 to 20 ppM, completely stopped the formation of hydrocarbons via radical reactions. Under these conditions, ethane was formed by a methylene insertion reaction with methane ($G(C_2H_6) = 0.276 \pm 0.02$) and hydrogen was formed by a series of ion molecule reactions ($G(H_2) = 2.73 \pm 0.06$). By using carbon-14 labeled acetylene, ethylene, and propyne, it was established, that in the absence of oxygen, ethylene and propylene are formed primarily by the addition of hydrogen atoms to acetylene and propyne, respectively. Ethane, however, was not formed by the addition of hydrogen atoms to ethylene, nor was propane formed from propyne or propylene. From the rate of disappearance of oxygen and ethylene, $G(H) = 4.7 \pm 0.3$ and $G(CH_3) \simeq 3.5$ were determined. Oxygen was a good scavenger for both hydrogen atoms and methyl radicals, whereas the olefins used were effective scavengers only for hydrogen atoms. The oxidation products formed from methane was CO_2 and CH_3OH, while acetylene was the principal precursor of CO and formaldehyde. (Disser. Abstr.)

35863 INFLUENCE OF HIGH-ENERGY RADIATION ON HIGH POLYMERS AND MORE PARTICULARLY ELASTOMERS. Zeplichal, F. (Bundesanstalt fuer Materialpruefung, Berlin-Dahlem, Ger.). Rev. Gen. Caout. Plast., 43: 971-8(July-Aug. 1966). (In French).

High-energy radiation creates trifunctional and tetrafunctional centers in the network of elastomers, the presence of O_2 favoring trifunctional centers. Description of chain deactivation by cross-linking procedures of this type during ^{60}Co irradiation is made. Protecting substances, in a concentration of 1 to 5% in as dispersed a form as possible, include sulfur-containing compounds and aromatic hydrocarbons. Qualitative studies indicate that angular bracketing of a ring notably improves its protective effect, and numerous graphs illustrate improvement by 3% 1,2-benzanthracene of the resistance of cis-1,4-polyisoprene to radiation. Tension as a function of stretching is decreased by this concentration of additive by 25 to 35% in nonvulcanized samples irradiated with 30 to 55 Mrad (relative to irradiated samples without benzanthracene) and by about 10 to 15% in vulcanized samples irradiated with 30 Mrad. The results of these experiments may be carried over to technical vulcanizates. (BBB)

35864 RETARDATION OF DISCOLORATION OF POLY(VINYL CHLORIDE) AND DECOLORIZATION OF DISCOLORED POLY (VINYL CHLORIDE) WITH DIIMIDE. Nakagawa, Tsutomu (Industrial Arts Inst. of the Japanese Government, Tokyo); Okawara, Makoto. J. Polym. Sci., Part A-1, 6: 1795-1807(July 1968).

Retardation of discoloration of poly(vinyl chloride) with diimide was studied in dimethylformamide at 130°C. with the use of p-toluenesulfonylhydrazide (PSH) as a source of diimide. A process was proposed that involved prolonging the induction periods of discoloration by inhibiting the development of conjugated polyene structure. The optimum proportion of PSH was one fourth of the poly(vinyl chloride). Poly(vinyl chloride) discolored by thermal degradation in o-dichlorobenzene or γ-irradiation under vacuum was decolorized in solution at 130°C. by addition of PSH. The decolorized poly(vinyl chloride) thus obtained was thermally stable compared with that obtained by oxidative methods. (auth)

35865 TRAPPING OF FREE RADICALS FORMED BY γ-IRRADIATION OF ORGANIC COMPOUNDS. Lagercrantz, C.; Forshult, S. (Univ. of Goteborg). Nature (London), 218: 1247-8(June 29, 1968).

Nitroso-compounds possess scavenger properties for free radicals, reacting to form unsymmetric nitroxide radicals which are sufficiently stable to be detected by ESR spectroscopy. Some studies on the trapping (as nitroxide radicals) of radicals formed by γ-irradiation of a variety of organic compounds, including sodium acetate, glycine, dl-α-alanine, β-alanine, dipotassium malonate, succinic acid, and l-glutamic acid hydrochloride are described. Irradiations were carried out at room temperature with about 5 MR γ-radiation from a ^{60}Co source, and aqueous t-nitrosobutane was used as scavenger. ESR spectra were recorded at room temperature. The coupling constants of the nitroxide radicals and the structure of the trapped radicals, as derived from the secondary splittings, are shown in tabular form, together with the structure of radicals known to be present in solid state samples after γ-irradiation at room temperature. Spectra are reproduced for glycine and dl-α-alanine. The results indicated that radicals trapped by the nitroxide method have a structure very similar to that of the corresponding species present in the γ-irradiated solid samples, and it is concluded that, apart from a possible difference in added protons, the trapped radicals are the primary species of the solid samples. No nitroxide radicals were detected with cysteine, cystine, and methionine, which probably contain radicals with the odd electron localised chiefly on the S-atom. It appears that the most stable nitroxide radicals are those formed by the trapping of radicals in which the odd electron is localised on a C-atom. (UK)

35866 IRRADIATED WOOD. WHAT IS IT. WHAT CAN IT DO. Frye, John. S. Lumberman, 211: 158-61(Dec. 15, 1965).

Irradiated wood is wood that has been impregnated under vacuum with a monomer plastic and exposed to radiation in a nuclear reactor or from ^{60}Co. The plastic in the wood cells polymerizes. The resulting wood is much harder, heavier, and more stable dimensionally. It can be shaped with standard wood-working tools. The new process of converting the woods is described. The sources of supply, economic aspects of production and use as flooring, construction units, furniture, industrial goods, and specialities are discussed. Problems of industrial conversion for commercial marketing are discussed and costs are tabulated and compared. (BBB)

35867 RADIATION CHEMISTRY OF THE ANTHRACENE OIL COMPONENTS. Proksch, E. Atomkernenergie, 13: 294-302 (1968). (In German). (SGAE-CH-47/1967).

The liquid-phase radiolytical decomposition of higher aromatic hydrocarbons was determined using nuclear reactor radiation (about 80% of the dose due to absorption of gamma radiation). The strong decrease in decomposition with increasing resonance energy is thought to be caused by the competition between radiationless conversion of excitation energy and decomposition of excited molecules. In the critical region near the C-H-dissociation energy, increasing resonance caused the distances between successive excited energy levels to decrease and thus the rates of nonradiative conversion to increase. By comparison with the stabilities of the anthracene oil components in the oil itself, the existence of radical scavenging reactions could be proven for higher aryl radicals, too. Application of these findings to the question of feasibility of anthracene oils as nuclear reactor coolants is discussed. (auth)

35868 POLYANIONS AND THEIR COMPLEXES. PART III. REACTIONS OF HEPARIN, HYALURONIC ACID, SODIUM POLY(ETHYLENESULPHONATE), SODIUM POLY(STYRENESULPHONATE), AND SODIUM CARBOXYMETHYLCELLULOSE WITH HYDROXYL RADICALS AND HYDRATED ELECTRONS. **Balazs, E. A. (Inst. of Biological and Medical Sciences, Boston); Davies, J. V.; Phillips, G. O. J. Chem. Soc., C, No. 12, 1420-3(1968).**

Pulse radiolysis techniques were used to obtain the rate constants for the reactions of e^-_{aq} and hydroxyl radicals with the above compounds. Comparison of the hydroxyl rate constants of the polyanions with those of the related monomeric repeating units indicates that the nature of the polyanion in solution exerts an important influence on reactivity. With the exception of hyaluronic acid the reactions of e^-_{aq} with the polyanions were generally slow. (auth) (UK)

35869 PRIMARY MODES OF DECOMPOSITION OF SUPER-EXCITED n-ALKANE MOLECULES. Ausloos, P.; Lias, S. G. (National Bureau of Standards, Washington, D. C.). Ber. Bunsenges. Phys. Chem., 72: 187-95(May 1968).

Information is summarized concerning fragmentation of superexcited propane and n-butane molecules produced by photolysis of these compounds with 11.6 to 11.8 eV photons, which is about 0.5 and 1.0 eV above the ionization energies of the two compounds. The decomposition of the excited $[C_3H_8^+]^*$ and $[C_4H_{10}^+]^*$ ions which are formed either by direct ionization or by autoionization are quenched at pressures around 10 Torr. These ions can then be removed from the photolysis system through a charge transfer reaction with added NO or an H_2 transfer reaction with low concentrations of added ethylene. The modes of decomposition of the superexcited alkane molecules were derived from the isotopic analysis of the products formed upon irradiation of $CD_3CH_2CD_3$, $CH_3CD_2CH_3$, $CD_3CH_2CH_2CD_3$, and of the equimolar mixtures $C_3H_8-C_3D_8$ and $C_4H_{10}-C_4D_{10}$. Comparison of these results with studies at longer wavelengths demonstrates that although the modes of decompositon observed at the superexcitation energies are the same as those observed at excitation energies below the ionization energy, free radical producing processes occur with higher probability when the energy of the photon is increased. (auth)

35870 ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED POLYETHYLENETEREPHTHALATE. Chapman, James Ronald. Nashville, Vanderbilt Univ., 1967. 89p.

Thesis.

Commercially produced samples of polyethyleneterephthalate (PET) were irradiated with one of three types of radiation, gamma, x, and ultraviolet. In addition, before the samples were irradiated they were confined in three types of environments of either dry nitrogen gas, air, or in a vacuum. The irradiation of the samples was performed at room temperature or at 77°K. Once the samples were irradiated they were observed in an electron spin resonance (ESR) spectrometer which utilized a 100 kHz synchronous detecting system constructed as a part of this work. It was found that the ESR spectra for the samples that were irradiated in vacuo at room temperature with gamma and x rays had a singlet with a peak-to-peak line width of 12 Oe. Those that were irradiated in nitrogen or air also yielded a singlet but had a line width of 40 Oe. The only difference noted was that the concentration of the radicals in samples irradiated in air was considerably lower than those irradiated in nitrogen. Furthermore, when the seal was broken on the samples irradiated in nitrogen the concentration of radicals decreased to a comparable concentration as those initially irradiated in air. The exposure necessary for the observation of the ESR spectra of the high-energy irradiated samples was on the order of 10^8 to 10^9 R. No ESR spectra was observed when PET was irradiated at room temperature. The irradiations performed at 77°K showed that the ESR spectra were independent of the environment in which the samples were confined. The exposure necessary to obtain these spectra was on the order of 10^6 R for the high-energy radiation. The spectra obtained, which were also observed at 77°K, consisted of a doublet and a singlet with "g" values of 2.002 and 1.934 respectively. The singlet is an excited state in the polymer. When the samples were raised to room temperature, light was emitted, and no ESR spectra were observed. The doublet is believed to be a free radical formed on one of the CH_2 groups of the main chain. When PET was irradiated with ultraviolet light at 77°K and the ESR spectra obtained at this temperature, a singlet was observed. The peak-to-peak line width was 14.5 Oe and is comparable to the 12 Oe singlet found with the high-energy irradiated in vacuo samples. This spectra disappeared when the sample was raised to room temperature and was the same regardless of the environment in which the sample was irradiated. (Disser. Abstr.)

35871 INVESTIGATION OF THE PHOTOCHEMISTRY OF THE URANYL–URANOUS SYSTEM IN ALDEHYDES. Haas, Rudolph M. Detroit, Wayne State Univ., 1963. 101p.

Thesis.

A qualitative study was made of the photochemical reduction of the uranyl ion by acetaldehyde and propionaldehyde in aqueous and nonaqueous media. The irradiation was carried out at 25°C using the 435 mμ mercury spectral line. The uranous ion and probably the monocarboxylic acid were the products. The products of the photochemical reaction in nonaqueous aldehyde solutions, entered into a reverse reaction, following an induction period. The length of this period was observed to decrease with the addition of acid and to increase with the addition of water. Products formed in aqueous media apparently entered into some reaction which prevented them from undergoing a reverse reaction. Conductivity measurements in propionaldehyde indicated dissociation of $UO_2(NO_3)_2 \cdot 6H_2O$ into ions. Infrared spectra, solubility measurements in water, and a characteristic paraldehyde odor, proved the polymerization of the acetaldehyde. Polymerization occurred in propionaldehyde, but at a slower rate. The empirical differential rate equations for the formation and disappearance of uranous ion in propionaldehyde are given. The probable mechanism for the forward and reverse reactions in terms of only those species which change oxidation state are proposed. It was not established as to what compound was responsible for the oxidation in the reverse reaction. (TSS) (Disser. Abstr.)

35872 IONIC PROCESSES IN THE LUMINESCENCE OF HIGH-ENERGY EXCITED SYSTEMS. Ludwig, P. K.; Huque, M. M. (Univ. of Notre Dame, Ind.). Ber. Bunsenges. Phys. Chem., 72: 352-4(May 1968). (COO-38-549).

The results obtained with charge scavengers confirmed the assumption that ionic reactions are involved in the luminescence of high-energy-excited, dilute solutions of organic scintillators in aliphatic solvents. The non-exponentiality of the luminescence decay can be understood as the result of the neutralization of scintillator ions with non-uniform distribution. Within a limited time range, the neutralization may be treated as resulting from electrostatic interaction between ion pairs. An exponential distribution function for ion pair separation was obtained. Current theoretical concepts of the interaction of high energy radiation with condensed media are presently being tested by extension of luminescence decay-time studies and techniques to excitation by more energetic γ radiation (for which short tracks are expected to play a smaller role). For such excitation, the luminescence decay curves should, according to the view presented, differ from those obtained with soft x-rays. (auth)

35873 PRIMARY PROCESSES IN RADIATION CHEMISTRY. **Heusinger, H. (Technische Hochschule, Munich). Chimia (Aarau), 22: 277-82(June 15, 1968). (In German).**

Radiation chemistry is compared with thermal chemistry and photochemistry. The reactions taking place between primary absorption of ionizing radiation and chemical reaction are discussed in detail. The role of ions, electrons, excited states, and radicals is pointed out and the influence of the ionization density (LET value) on product formation is explained. The radiolysis of water is taken as example to demonstrate the development of the concept of radiation chemistry. (auth)

35874 PREPARATION OF ELEMENTARY HIGH-SPECIFIC ACTIVITY ^{35}S. **Gol'tyapin, Yu. V.; Zaslavskii, I. I.; Kondrakhina, S. I. Zh. Prikl. Khim., 41: 698-701(Apr. 1968). (In Russian).**

A method for producing high-specific activity (up to 25 Ci/g) ^{35}S by direct neutron-irradiation of potassium chloride was developed under special laboratory conditions. The method consists of reduction of sulfate and oxidation of separated hydrogen sulfide to elementary sulfur. (R.V.J.)

35875 RADIO-GAS-CHROMATOGRAPHY OF MONO-, DI-, AND TRI-BROMOBENZENES LABELED WITH ^{82}Br. APPLICATION IN RECOIL CHEMISTRY. **Larsen, E.; Siekierska, K. E.;**

Fenger, J. (Danish Atomic Energy Commission, Roskilde). J. Gas Chromatogr., 6: 171-2(Mar, 1968).

A method for separation of mono-, di-, and tri-bromobenzenes by gas chromatography was developed for determination of the relative yields of carrier-free ^{82}Br-labeled species by radioactivity measurement of the outflow of the column. When the method is applied in quantitative analysis in the recoil chemistry of crystalline bromobenzenes, the relative yield of free ^{82}Br atoms can be determined after quantitative exchange with 1,2-dibromoethylene to form labeled dibromoethylene. Analyses were performed with a gas chromatograph equipped with a flame ionization detector. For detection of the radioactivity, a counting volume in the form of a flat Al cylinder was placed between the outlet of the column and the ionization detector in a separately thermostated shielded oven. The γ quanta emitted were detected with a NaI scintillation probe. To protect the crystal against the heat of the gas, the crystal was placed outside the thermostated oven through an 8-cm Pb collimator; hence its overall efficiency was relatively small (1%). Activity and mass chromatograms are illustrated and discussed. (BBB)

Radiochemistry

35876 (LA-3956) ON THE ACCUMULATION OF He-H MOLECULAR COMPLEXES. Sikora, P. T.; Depatie, David; Schuch, A. F. (Los Alamos Scientific Lab., N. Mex.). June 10, 1968. Contract W-7405-eng-36. 2p. Dep. CFSTI.

Liquid tritium is proposed as an agent for producing and stabilizing macroscopic quantities of He-H molecular complexes. Information on their existence could be inferred from simple pressure measurements. (auth)

35877 REACTION CAPACITY OF RADIOACTIVE SODIUM BICARBONATE $NaH^{14}CO_3$. THERMAL DECOMPOSITION IN NITROGEN ATMOSPHERE. Pavlyuchenko, M. M.; Slyshkina, S. A.; Prodan, E. A. (Inst. of General and Inorganic Chemistry, Minsk). Dokl. Akad. Nauk BSSR, 12: 348-52(Apr. 1968). (In Russian).

The kinetics of the thermal decomposition of radioactive sodium bicarbonate (dimensions of the particles from 0.3 to 2.9 μ) with specific activity of 95 mCi/g and of two inactive samples (one finely dispersed (0.3 to 3.3 μ) and the other coarsely crystalline (2 to 160 μ)) were investigated under nitrogen atmosphere. The first two were decomposed at a measurable rate at much lower temperature (40 to 100°) than the latter (100 to 160°). During the reaction the activation energy remained constant in the limits from 18.4 to 20.4 kcal/2 mole (radioactive bicarbonate), decreased from 28.6 to 24.0 (finely dispersed), or decreased from 48.5 to 22.5 kcal/2 mole (coarsely crystalline). The samples studied differed according to the effects of the temperature on the kinetic curves and the size of the region of rate increase. After complete decomposition the external form of the crystals was preserved unchanged. (tr-auth)

35878 INVESTIGATION OF POLYETHYLENE BY EMANATION-THERMAL METHODS. Zaborenko, K. B.; Bekman, I. N. Radiokhimiya, 10: 268-71(1968). (In Russian).

A method for the activation of polyethylene for emanation studies was developed. The efficiency of the emanation-thermal analysis for the study of the crystallization, pressure, and different kinds of the structural changes in polymers was found. It was also found that pyrolysis emanograms of polyethylene reflect an effect connected with the destruction and oxidation of macrochains of the polymer. (tr-auth)

Separation Processes

Refer also to abstract 35795.

35879 (ANL-7450) CHEMICAL ENGINEERING DIVISION RESEARCH HIGHLIGHTS, MAY 1967-APRIL 1968. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 127p. Dep. CFSTI.

Separate abstracts were prepared for each of the seven sections. (M.C.G.)

For abstracts of individual sections see: 35880, 35881, 36543, 36774, 37312, and 37402.

35880 (ANL-7450, pp 7-20) COMPACT PYROCHEMICAL PROCESSES. (Argonne National Lab., Ill.).

Topics covered include: a continuous salt transport process flow sheet, supporting laboratory studies, supporting engineering studies, and experimental flow sheet investigations. (M.C.G.)

35881 (ANL-7450, pp 21-38) VOLATILITY AND FLUIDIZATION PROCESSES. (Argonne National Lab., Ill.).

Research progress is reported on the recovery of uranium and plutonium from spent fuels by volatility and fluidization processes. Topics covered include: engineering development of fluorination of uranium oxide by BrF_5, engineering-scale alpha facility operations, bench-scale fluid-bed studies with irradiated fuels, and ruthenium fluoride separation chemistry. (M.C.G.)

35882 (DP-MS-66-78) SUPPRESSION OF RADIOIODINE RELEASES FROM A RADIOCHEMICAL SEPARATIONS PLANT. Smith, S. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar. 28, 1967. Contract AT(07-2)-1. 10p. (CONF-670401-15). Dep. CFSTI.

From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

In the Savannah River Plant Purex process, mercury was tested to suppress the release of radioiodine by complexing the iodine. Suppressing the release of radioiodine would be desirable in the event that short-cooled fuel were inadvertently charged to the dissolver in the plant. When irradiated uranium reactor fuels are processed, radioiodine is normally evolved during dissolution with HNO_3, clarification, subsequent solvent extraction, and waste evaporation. Normally (without mercury), about 50% of the radioiodine is evolved from the dissolver solution and efficiently sorbed in a silver nitrate bed, but the small amount evolved from the remainder of the process is released to the atmosphere through tall stacks. This release is suppressed by adding mercuric nitrate to the dissolver solution, according to recent tests at the Savannah River Plant. With 0.04M Hg^{2+} in the dissolver solution and a gelatin clarifier, the radioiodine release was reduced 55-fold. A material balance indicated that the Hg-I complex remained in the organic solvent where it was slowly removed by solvent scrubbers and subsequently transferred to a seepage basin. In another test, 5×10^{-4}M Hg^{2+} in the dissolver and a MnO_2 clarifier reduced ^{131}I releases a total of 22-fold. In tests without Hg^{2+}, MnO_2 clarification reduced ^{131}I releases 2.5-fold over the normal gelatin clarification. 4×10^{-4}M Hg^{+} was not more effective than 5×10^{-4}M Hg^{2+} in suppressing ^{131}I evolution. (auth)

35883 (EUR-3922) IL TUFO GIALLO NAPOLETANO NEL TRATTAMENTO DI EFFLUENTI LIQUIDI RADIOATTIVI. (The Use of Neapolitan Yellow Tufa in the Processing of Radioactive Liquid Waste). Bocola, W.; Boenzi, D.; Branca, G.; Lenzi, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 82p. (In Italian). Dep.

A study was conducted on a natural zeolitic inorganic exchanger found widely in certain Italian provinces, the Neapolitan yellow tufa (TGN). The chemical, morphological, and structural properties of this substance were ascertained through a series of chemical, optical, diffractometric, heat differential, and heat/weight analyses. The principal exchange characteristics of TGN were determined, more especially the values of the Cs^{+}, Sr^{2+} and Ce^{3+} exchange capacity and of the distribution coefficient with Cs^{+}, Sr^{2+}, Ce^{3+}, Fe^{3+}, Ru (NO) NO_3, Ru^{3+}, Nb (oxalate complex), and Zr (oxalate complex) in various solutions. The TGN exchange kinetics with Cs^{+}, Sr^{2+} and Ce^{3+} were also evaluated. TGN was then employed to decontaminate solutions containing ^{137}Cs, ^{90}Sr, ^{85}Sr, and mixed fission products, under various experimental conditions, i.e., in mixer-settlers, by formation of sludge in the solution to be processed, in flocculators, as an additive in coprecipitation and flocculation processes, and in column. The various parameters on which these treatments depend were studied, and quantitative evaluations were made of the performances obtainable with TGN in the various modes in which it can be employed. Experiments were conducted on the transformation of TGN by heat processes into an insoluble vitreous-ceramic product for final disposal of the contaminated spent waste. (auth)

35884 (NYO-4444) FIXATION IN VITREOUS MATRICES OF HIGH ACTIVITY FISSION PRODUCT WASTES FROM AQUEOUS REPROCESSING OF SPENT STAINLESS STEEL-URANIUM FUEL ELEMENTS. Goldman, Morton I.; Tebbutt, T. H. Y.; McLain, A. R.; Kim, Byung C.; Eliassen, Rolf (Massachusetts Inst. of Tech., Cambridge. Sedgwick Labs. of Sanitary Science). Feb. 1, 1960. Contract AT(30-1)-621. 204p. Dep. CFSTI.

Research was carried out on the fixation of high-activity fission product wastes from the reprocessing of spent stainless-steel fuel elements by firing with lime and sand to a glassy state. Volume reduction factors (ratio of volumes of liquid wastes to glass) as high as 32.8 were obtained. The glass would immobilize as high as 70 wt % of calcined waste oxides. Leaching rates of ^{137}Cs from these vitreous matrices by boiling distilled water ranged from 7.7×10^{-6} to 4.8×10^{-5} cm/wk, expressed as corrosion rate of glass. The corrosion rate decreased for strontium, iron, and zirconium, in that order. Zirconium-based corrosion rates ranged from 8 to 10×10^{-6} cm/wk. Composition parameters had a relatively small effect on corrosion rates in comparison with the effects introduced by firing conditions; both underfiring and slow cooling of the

fusions increased the cesium corrosion rates by significant amounts. Electron-beam irradiation of selected samples to a dose of 10^{10} rad generally had a small effect on the corrosion rates. Cesium was lost from the fusions during the firing process in amounts ranging from 0 to 66% of the original cesium present. At temperatures below 1450°C, the cesium lost from the glass was apparently retained in the clay crucible and lid. No cesium was lost during evaporation and denitration of the liquid waste at temperatures up to 800°C. Assuming that crucibles and their contents will be stored in underground vaults, preliminary calculations indicate that cooling with air by natural convection is feasible with glass heating densities below about 2000 BTU/hr-ft^3. The cost of waste processing by glass formation and storage would approximate 0.1 mills per kwh of electrical energy produced. (auth)

35885 SOLVENT EXTRACTION OF TECHNETIUM AND MOLYBDENUM BY TETRAALKYLAMMONIUM IODIDES. Shanker, R.; Venkateswarlu, K. S.; Shankar, J. (Bhabha Atomic Research Centre, Trombay, India). J. Less-Common Metals, 15: 311-16 (July 1968).

Solvent extraction of Tc and Mo using quaternary ammonium iodides in benzene and chloroform was carried out in neutral and alkaline media. The influence of the anomalous activity coefficients of the extractants on the solvent dependency has been examined. The separation of Tc from Mo with good single stage separation factors is reported. (auth)

35886 PROCESSING OF METAL FLUORIDES INCLUDING URANIUM HEXAFLUORIDE WITH ANHYDROUS HYDROGEN FLUORIDE. Grant, Albert Edgar (to United Kingdom Atomic Energy Authority). U. S. Patent 3,383,183. May 14, 1968. Priority date Oct. 5, 1964, Great Britain.

A metal fluoride is separated from a mixture of metal fluorides including UF_6 by treating the mixture with liquid anhydrous HF to dissolve at least some of the UF_6 and at least some of one or more other metal fluorides soluble in HF, and subsequently treating the solution to recover metal fluoride from the solution. UF_6, for example, can be separated from mixtures of various metal fluorides. (auth)

35887 DETERMINATION OF SCANDIUM IN THE PRESENCE OF YTTRIUM AND LANTHANUM. Agafonova, V. I.; Ryazanov, I. P. Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 11: 395-8(1968). (In Russian).

The separation of scandium from yttrium and lanthanum by diphenic acid is described. It is shown that diphenic acid precipitates scandium as a crystalline precipitate of basic scandium diphenate. Statistical data for the separation of Sc from Y and La using scandium diphenate are tabulated. (R.V.J.)

35888 USE OF OXIDIZING ACID MIXTURES TO DISINTEGRATE FUEL INSERTS FOR GAS-COOLED HIGH-TEMPERATURE REACTORS. Bildstein, H.; Knotik, K. (Reaktorzentrum, Seibersdorf, Austria). Kerntechnik, 10: 255-9(May 1968). (In German and English).

A disintegration method was developed for investigations of fuel inserts of high-temperature reactors, which allows a rapid and clean separation of the graphite bodies into coated particles and fine graphite powder. It is based on an oxidative attack of graphite at grain boundaries and on an enhancement of the structure breakdown by intensive gas evolution, using as oxidizing agent $(NH_4)_2S_2SO_8$ dissolved in H_2SO_4 (96%). The speed of deconsolidation is increased by penetration of sulfuric acid. Fuel inserts prepared by compacting homogenized mixtures of coated particles and graphite powder are completely disintegrated in 20 minutes; fuel inserts with electro-graphite shells require about 1 hour. No additional defects are caused by disintegration; this makes it possible to determine exactly the particle defects occurring during fabrication and irradiation. The method can also be used as the head-end step in reprocessing. (auth)

35889 THE REPROCESSING PLANT IN JAPAN. Curillon, Robert; Viennot, Jacques. Energ. Nucl. (Paris), 10: 160-8 (May 1968). (In French).

Saint-Gobain Techniques Nouvelles (S.G.N.) was awarded the complete design of the reprocessing plant to be built in Japan. This design is essentially based on the mechanical and chemical process developed by the C.E.A. in France, but this project presents several original characteristics, such as the fuel chopping facility, which is described briefly together with the particular requirements for safety, building layout, and construction, due to the special geographical conditions in Japan. (auth)

35890 PROCESSING IRRADIATED FUELS BY DRY METHODS. Bourgeois, M. (CEA-CEN, Fontenay-aux-Roses, France); Cochet-Muchy, B. Energ. Nucl. (Paris), 10: 192-200(May 1968). (In French).

After a brief review of the main dry methods for processing irradiated fuels and of the essential characteristics of these methods, an outline of the work done in France is presented. In addition to a description of the Attila facility, the first results obtained at Fontenay-aux-Roses on unirradiated fuels are also given. (auth)

35891 APPLICATIONS OF SOLVENT EXTRACTION TO CONCENTRATION AND PURIFICATION OF PLUTONIUM. I. MARCOULE: UTILIZATION OF TRIBUTYL PHOSPHATE. Auchapt, P.; Giraud, J.-P.; Talmont, X. Energ. Nucl. (Paris), 10: 181-6(May 1968). (In French).

In order to improve the operating conditions and decrease the operating cost of the Marcoule processing plant, a second plutonium purification cycle, also used as a concentration cycle, was developed. This cycle includes a plutonium extraction step with tributyl phosphate followed by a reducing-stripping extraction step. The reducer used is uranous nitrate stabilized with hydrazine. A reflux extraction provides a constant concentration solution of plutonium. A facility equipped with pulsed columns and based on this flowsheet started operation in August 1967. Achieving the expected performances, it allowed a decrease in the volume of medium-activity effluents. (auth)

35892 INVESTIGATION AND TESTING OF THE EXTRACTION PROCEDURE USED IN THE JAPANESE PLANT. Lefort, Guy (Commissariat a l'Energie Atomique, Paris); Miquel, Pierre; De Rubercy, Michel. Energ. Nucl. (Paris), 10: 169-80(May 1968). (In French).

After a brief review of the reasons for trying, in high radioactivity environment, a purification method for oxide-type irradiated fuel, the optimum technological conditions thus experimentally defined are described. The tests were carried out with fuel elements some of which were submitted to heavy burnup; they permitted a more precise determination of the decontamination factors expected in the industrial-scale plant and provided very encouraging information on the purity of the endproduct, the loss ratio of fissile material, and the safety margins of the process. (auth)

35893 APPLICATIONS OF SOLVENT EXTRACTION TO CONCENTRATION AND PURIFICATION OF PLUTONIUM. II. THE HAGUE: UTILIZATION OF TRILAURYLAMINE. Bathellier, A.; Grieneisen, A.; Plessy, L. (Commissariat a l'Energie Atomique, Paris). Energ. Nucl. (Paris), 10: 186-91(May 1968). (In French).

In the plant at the Hague, both the final purification and concentration steps of plutonium are carried out in a single extraction–stripping cycle using trilaurylamine. This solvent has a very high distribution ratio for plutonium, as well as a selectivity that is comparable to tributyl phosphate. Its radiation stability is high enough if temperature increases are avoided and if nitrous acid is eliminated. Industrial use of this solvent confirmed laboratory performances. (auth)

35894 THE HEAVY WATER PLANT OF MAZINGARBE. Roth, E. (CEN, Saclay, France); Bedhome, A.; Lefrancois, B.; Le Chatelier, J.; Tillol, A. Energ. Nucl. (Paris), 10: 214-19(May 1968). (In French).

Research and studies carried through in order to establish the industrial process for heavy water production used in Mazingarbe are described. This process is based on deuterium extraction from hydrogen utilized for ammoniac synthesis by isotopic exchange between ammonia and hydrogen. Technical problems of the construction and operation of the Mazingarbe plant are briefly described. (auth)

35895 VITRIFICATION PILOT PLANT FOR FISSION PRODUCTS AT MARCOULE. Bonniaud, M.; Kersale, M.; Rozand, M. Energ. Nucl. (Paris), 10: 201-9(May 1968). (In French).

Piver, the vitrification pilot plant at Marcoule, does research on vitrification of fission products on an industrial scale. The plant uses the semicontinuous process of pot vitrification involving casting of glass into storage crucibles and reuse of the pot. The vitrification complex at Marcoule was installed in an extension of the pilot irradiated-fuel processing plant, whose overall layout it adopts (working areas, cells, etc.) and whose supporting general services it shares. It is completed by an independent glass storage building, partially dug in and air-cooled. (auth)

35896 LOW-TEMPERATURE LUMINESCENCE SPECTRA IN THE STUDY OF THE ROLE OF THE SALTING OUT AGENT DURING THE EXTRACTION RECOVERY OF URANIUM(VI). Dobrolyubskaya, T. S.; Anikina, L. I. Radiokhimiya, 10: 162-6(1968). (In Russian).

On the basis of the study of the luminescence spectra (at −190°C) it was concluded that the introduction of a salting out agent into a

dilute solution of uranyl nitrate leads to the displacement of the equilibrium in the solution to the side of the formation of nondissociated molecules of $UO_2(NO_3)_2$, the presence of which is necessary for carrying out the extraction. (tr-auth)

35897 REPRODUCIBILITY OF THE RESULTS DURING THE EXTRACTION OF MICROQUANTITIES OF ZIRCONIUM FROM NITRIC ACID SOLUTIONS BY DI-P-CRESYLPHOSPHORIC ACID. Fomin, V. V.; Potapova, S. A. Radiokhimiya, 10: 167-75(1968). (In Russian).

In solutions of zirconium salts with nitric acid from 1 to 5 M, prepared by acidification of weak acid or neutral solutions, some forms of zirconium existed which were extracted with 2-TTA but not with D-p-CP (di-p-cresylphosphoric acid). They were slowly converted in the extraction with D-p-CP. The conversion rate increased with increase of the HNO_3 concentration. (tr-auth)

35898 EXTRACTION SEPARATION OF RADIOACTIVE MANGANESE FROM LARGE QUANTITIES OF IRON. Brigevich, R. F.; Kuznetsov, R. A. Radiokhimiya, 10: 243-6(1968). (In Russian).

The distribution coefficients of manganese thiocyanate were determined in relation to the pH and the electrolyte concentration in aqueous solution during extraction with mixtures of TBP–kerosene. A method for the separation of radioactive manganese from large quantities of iron is proposed. (tr-auth)

35899 SYNERGISTIC AND SOLVENT EFFECTS IN THE EXTRACTION OF STRONTIUM AND SODIUM BY DI(2-ETHYLHEXYL) PHOSPHATE. McDowell, W. J. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Inorg. Nucl. Chem., 30: 1037-49(May 1968). (ORNL-P-3384).

Strontium extraction by solutions of mixed sodium-hydrogen bis(2-ethylhexyl) phosphate (Na-HDEHP) is affected by the diluent used and by various organic phase additives. Two effects were noted, one on the acidity of the extractant due to the relative Lewis acidity of the diluent or additive, and one due to more direct molecular interaction with the extracted metal (synergism) or with the extractant (antagonism). The synergistic effect of TBP on strontium extraction was examined in detail and was found to be due to substitution of TBP for HA in the compound $SrA_2 \cdot 4HA$ (A = DEHP). A range of substituted compounds from $SrA_2 3HA \cdot TBP$ to $SrA_2 \cdot 4TBP$ was observed. The point of maximum synergism was found with 60% of the total phosphate as TBP and 30% of the DEHP as NaDEHP. Interaction of TBP with NaDEHP species was observed, and aggregation of TBP in dilute, wet n-octane solutions is suggested. (auth) (UK)

35900 THIN-LAYER CHROMATOGRAPHIC SEPARATION OF DIETHYLDITHIOCARBAMATE CHELATES. Kiboku, Mitsuo (Kinki Univ., Hiroshima). Bunseki Kagaku, 17: 722-7(June 1968). (In Janapese).

Colored chelates of diethyldithiocarbamate with Bi^{3+}, Cu^{2+}, Ni^{2+}, Co^{2+}, Fe^{2+}, CrO_4^{2-}, MoO_4^{2-}, VO_3^-, and UO_2^{2+} were extracted into chloroform and separated on a silica gel thin-layer. By a development with benzene or cyclohexane–chloroform (30 : 70), their R_f's were in the following decreasing order: Cu > Mo > Ni > Cr > Co > Bi > Fe > V > Cr > U. Their detection limits on the thin-layer were: Bi 0.1, Cu 0.002, Ni 0.08, Co 0.04, Fe 0.04, Cr 0.3, Mo 0.05, V 0.05, and U 0.02, each in μgs. (auth)

35901 EXTRACTION OF THORIUM BY SECONDARY AMINES. Awwal, M. A. (Atomic Energy Centre, Dacca, Pakistan); Carswell, D. J. J. Inorg. Nucl. Chem., 30: 1057-63(May 1968).

Results are reported for the extraction of thorium from aqueous sulfate media by secondary amines. These results indicate that extremely high partition coefficients are obtained at low sulfate concentrations and that extraction occurs in conditions where anionic thorium complexes are formed. Anomalous extraction behavior was observed at solvent concentrations greater than 10^{-2}N. The experimental evidence suggests that six amine molecules are associated with each extracted thorium atom, which is itself monomeric, and that hydrogen bonding plays a role in the extraction process. (auth) (UK)

35902 APPARATUS FOR DECANNING FUEL ELEMENTS. Faugeras, Pierre; Stratakis, Jean (to Commissariat a l'Energie Atomique). U. S. Patent 3,382,046. May 7, 1968. Priority date Jan. 20, 1965, France.

An apparatus is described for decanning fuel elements by a continuous chemical process. The process consists in continuously circulating the canned fuel elements within the apparatus, dissolving the cans with a continuous cocurrent flow of acid etching solution, and rinsing the decanned fuel elements with a countercurrent flow of neutral rinsing solution. The apparatus comprises an inclined vessel of elongated shape divided into two adjacent chambers communicating with each other at the lower end. Screw conveyor means are provided for conveying canned fuel elements downwardly with the cocurrent flow of acid etching solution in the upper chamber, and upwardly against the countercurrent rinsing flow in the lower chamber. Mechanisms are provided for introducing and removing the fuel elements. (D.L.C.)

35903 INVESTIGATION OF THE SORPTION FROM AQUEOUS SOLUTION OF ^{137}Cs, ^{90}Sr, AND ^{91}Y BY SYNTHETIC ZEOLITES OF THE X TYPE IN SODIUM FORM. Shchebetkovskii, V. N. Radiokhimiya, 10: 151-6(1968). (In Russian).

The dependence of the sorption of ^{137}Cs, ^{90}Sr, and ^{91}Y by X-type zeolites in the sodium form was studied as a function of the content of sodium chloride and humus material in the solution. The sorption of ^{137}Cs and ^{90}Sr by NaX zeolite did not depend on the presence of humus material in the solution and increased linearly with decrease of the NaCl concentration in the limits from 0.5 to 10^{-3} N, and in the case of Cs the absence of the effect of a change in the solution pH was noticeable in the regularity of the ion exchange of Na on Cs. The effects of the presence of humus materials in the solution on the sorption of ^{91}Y by NaX zeolite were found as a result of the formation of associations of Y with this material. (tr-auth)

35904 EXTRACTION OF MIXTURES OF RADIOACTIVE ISOTOPES WITH NATURAL NAPHTHENIC ACID. Alekperov, R. A.; Makov, N. N. Radiokhimiya, 10: 241-3(1968). (In Russian).

The extraction of microquantities of radioactive isotopes with natural naphthenic acid was investigated. The radioisotopes used in the study were ^{59}Fe, ^{51}Cr, ^{54}Mn, ^{60}Co, ^{90}Sr, ^{91}Y, ^{95}Zr, ^{95}Nb, ^{106}Ru, ^{144}Ce, ^{147}Pm, and ^{134}Cs. The extraction was studied in relation to the equilibrium pH of the aqueous phase, and the results are shown graphically. The graph indicates that each element can be extracted in a fixed pH range and most of them can be extracted quantitatively. (J.S.R.)

35905 RADIOCHEMICAL ANALYSIS BY MEANS OF ION-CHANGE LAYERS IN MIXED AND NONAQUEOUS SOLVENTS. III. COMPARISON OF THE CONDITIONS OF THE ANION EXCHANGE SEPARATION OF SOME RADIOACTIVE RARE EARTHS AND ^{91}Y IN WATER–ALCOHOL SOLUTIONS, CONTAINING NITRIC ACID OR METAL NITRATE. Bogatyrev, I. O.; Zaborenko, K. B.; Malygina, N. L. Radiokhimiya, 10: 253-5(1968). (In Russian).

The distribution coefficients of ^{140}La, ^{144}Ce, ^{143}Pr, ^{147}Pm, ^{152}Eu, and ^{91}Y on the anionite AV-17 in water–alcohol solutions containing nitric acid or acidified solutions of inorganic nitrates $LiNO_3$ or $Al(NO_3)_3$ were studied. It was found that the replacement of nitric acid by the metal nitrates, especially the multivalent metal, substantially increased the distribution coefficients of the rare earth elements and ^{91}Y on the anionite AV-17 in water–alcohol solutions containing the NO_3^- ion. (tr-auth)

35906 ADSORPTION PROPERTY OF RADIOACTIVE MATERIALS BY COAL HUMIC ACID. Matsumura, Takashi. Nippon Genshiryoku Gakkaishi, 10: 310-12(1968). (In Japanese).

The adsorption property of coal humic acid extracted from oxidized coal has been investigated in a batch system using test liquids containing $^{137}Cs-^{137}Ba$, ^{89}Sr, and ^{60}Co. The coal humic acid appears to have a graphite-like structure in which the aromatic nucleus is dominant. The performance of coal humic acid as ion exchanger was appreciably improved by changing it into Na-form by pre-treatment with NaCl solution. The distribution coefficients were higher for ^{89}Sr and ^{60}Co than for $^{137}Cs-^{137}Ba$ and had satisfactorily high values in the pH range between 4 and 7. The distribution coefficients decreased with increasing competing Na or Ca ion concentration; in the presence of Ca ions of considerably high concentration, the distribution coefficient was higher for $^{137}Cs-^{137}Ba$ than for ^{89}Sr and ^{60}Co. (auth)

35907 OXYGEN SCAVENGING DEVICE. Skladzien, Stanley B. (to United States Atomic Energy Commission). U. S. Patent 3,387,969. June 11, 1968.

A method is described for reducing the oxide content of alkali metals to <10 ppM. The alkali metal is flowed past a membrane of Zr or a Zr alloy that is maintained at 1200 to 1300°F while a molten Ca-containing alloy is flowing on the other side of the membrane. The surface of the Zr-containing membrane acts as a continuous scavenger, and the unique diffusion of the oxide through the membrane into the Ca-containing alloy serves to continuously regenerate the scavenger. (B.L.M.)

35908 IRRADIATED FUEL REPROCESSING. Erlandson, Otto D.; Judson, Burton F. (to General Electric Co.). U. S. Patent 3,374,068. Mar. 19, 1968. Filed Nov. 17, 1966.

In a process for treating irradiated reactor fuel to recover U and either Pu or Np substantially free from other fission products, the fuel is first dissolved in a strong mineral acid to form

an aqueous dissolver solution. The dissolver solution is contacted with a lean organic solvent to form an organic extract containing U and Pu or Np and an aqueous solvent extraction raffinate from which the fission products are recovered by dehydration. The organic extract is stripped to produce an aqueous extract containing the U and Pu or Np, and this aqueous extract is contacted with an anion exchange resin to adsorb the Pu or Np. The aqueous raffinate from the anion exchange resin is dehydrated and calcined to form uranium oxide, which is fluorinated to produce UF_6. The Np or Pu can be eluted and recovered from the resin. (B.L.M.)

35909 ENRICHMENT OF ISOTOPES OF LITHIUM. (to Nederlandse Centrale Organisatie Voor Toegepast: Natuurwetenschappelijk Onderzoek). British Patent 1,115,929. June 6, 1968. Priority date June 5, 1964, Netherlands.

A process for enriching Li isotopes by selective distribution into two liquids in contact with each other is carried out in an apparatus comprising an exchange column in which Li amalgam is in contact with a solution of a Li halide in at least one organic amine with a boiling point below 100°C, preferably propylamine and/or isopropylamine. In a reflux section at the upper end of the column, the Li salt is transferred from the amine solution into an aqueous solution and subsequently converted by electrolysis into Li amalgam. In a return circuit including the lower end of the exchange column the Li is transferred from the amalgam into the organic amine solvent by countercurrent ion exchange, and an auxiliary salt is supplied to the exchange column in a quantity slightly below the equivalent quantity of the Li supplied to the column. Part of the amalgam enriched in one isotope is withdrawn from the return circuit before the complete transfer of the Li from the amalgam to the organic amine solvent in that circuit. (B.L.M.)

35910 COATED DIATOMITE FOR TREATMENT OF RADIOACTIVE WASTES. Andersen, Dewey Richard. Iowa City, Iowa, Iowa State Univ., 1967. 142p.

Thesis.

Diatomite (or perlite) filter aid coated with an inorganic base exchange material was prepared for decontaminating radioactive wastes. The basic constituents used in preparing the coated material included diatomite (or perlite) filter aid, sodium silicate solution, sodium aluminate, and caustic soda. The resulting medium had an ion-exchange capacity of 0.75 to 0.80 meq/g. When used as a filter aid, this material will remove particulate matter by the filtration process and dissolved cations by the base exchange materials. In a column study in the laboratory using a ^{89}Sr solution, a decontamination factor of ≥1000 was obtained. In addition, some depleted, radioactive material was converted into glass. The glass product was evaluated for chemical durability. The purpose of this portion of the study was to evaluate this method of final disposal for the radioactive waste material. The glass mix was melted at 1090°C and was air cooled. For the chemical durability study, −40 + 60 mesh glass particles were submerged in boiling distilled-demineralized water in a reflux condenser apparatus. The apparent corrosion rate of the glass was about 1.4×10^{-5} cm/wk. (Diss. Abstr.)

35911 FRACTIONAL SUBLIMATION OF SOME METAL CHELATES OF THENOYLTRIFLUOROACETONE. Berg, Eugene W.; Reed, Kenneth P. (Louisiana State Univ., Baton Rouge). Anal. Chim. Acta, 42: 207-12(Aug, 1968).

Studies on the fractional sublimation of various metal β-diketone chelates were extended to include the chelates of thenoyltrifluoroacetone (TTA). Many of the common metal chelates were found to be stable, to sublime readily, and to form well-defined zones in the vacuum fractional sublimator. Of the 17 chelates reported only those of manganese(II) and iron(II) were not volatile. The chelates of UO_2(II), Zr(IV), Pb(II), and Cr(III) partially decomposed during sublimation and their recovery was incomplete. The recovery of the sublimed chelates of Ni(II), Mg(II), Al(III), Pd(II), Co(II), Cu(II), Fe(III), Tl(III), Zn(II), and Be(II) ranged from 87 to 100%, with most recoveries being quantitative. The sublimation recrystallization zone temperatures of the various chelates are compared to those of the metal acetylacetonates and the benzoyltrifluoroacetones; in general, the metal chelates of TTA sublime more readily than those of benzoyltrifluoroacetone but are potentially less useful for fractional sublimation separations than the corresponding metal acetylacetonates. Even so, a quantitative separation of iron(III) from Ni(II), Al(III), Mn(II), and Fe(II) is proposed that depends upon the fractional sublimation of the TTA chelates. (auth)

35912 SEPARATION OF FISSION PRODUCTS BY ELECTROPHORETIC FOCUSSING OF IONS. PART II. Pauwels, M.; Gijbels, R.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 42: 213-18(Aug. 1968).

Electrophoretic focussing of ions was applied to the separation of the long-lived fission products Zr, Nb, Ru, Y, Ce, Sr, and Cs. With hydrofluoric acid and nitrilotriacetic acid as the anodic and cathodic electrolytes respectively, a quantitative separation of Zr, Nb, Sr, and Cs was obtained whereas Ru, Y, and Ce did not focus sharply. The nuclides were detected by γ- and β-counting. (auth)

35913 SOLVENT EXTRACTION OF ALKALI METAL IONS WITH CHROMIUM COMPLEXES. Fujinaga, Taitiro; Koyama, Mutsuo; Tochiyama, Osamu (Kyoto Univ.). Anal. Chim. Acta, 42: 219-24(Aug. 1968).

Solvent extraction of alkali metal ions by batch and countercurrent distribution methods was investigated with tetrathiocyanatodiamminechromate(III) and tetrathiocyanatodianilinechromate(III) as reagents and nitromethane and nitrobenzene as organic solvents. The distribution ratios of alkali metal ions in the various systems were measured. Cesium was readily extracted with the aniline compound and nitrobenzene. The separation of sodium from potassium in trace amounts was possible by the counter-current distribution method. (auth)

35914 ADSORPTION OF SOME ELEMENTS IN ACETIC ACID MEDIUM ON DOWEX 1-X8. van den Winkel, P.; de Corte, F.; Speecke, A.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 42: 340(Aug. 1968).

The adsorption of 14 elements on Dowex 1-X8 (100 to 200 mesh) from acetic acid concentrations varying from 6 to 17.5 M was examined. The ions investigated were As(III), Au(III), Br^-, Co(II), Cs(I), Cu(II), Fe(II), Hg(II), K(I), Mn(II), M_o(VI), Na(I), Sc(III), and Zn(II). Since all the elements except the alkali metals are absorbed from glacial acetic acid, this medium should be suitable for the separation of ^{24}Na as well as ^{42}K from all the other induced activities in the neutron activation of biological materials. (D.H.M.)

35915 THE EXTRACTION OF URANIUM(VI) FROM SULPHURIC ACID SOLUTIONS BY LONG-CHAIN ALIPHATIC AMINES. Sato, Taichi (Shizuoka Univ., Hamamatsu, Japan). J. Inorg. Nucl. Chem., 30: 1065-74(May 1968).

The partition of uranium(VI) between sulphuric acid solutions and organic solutions of long-chain aliphatic amines was investigated, and an ir study was made of the organic phases. The effects of amine structure and organic solvent and the mechanism of uranium extraction are discussed. Amines investigated included MDA (mono-n-dodecyl), DOA (di-n-octyl), DDA (di-n-dodecyl), DMDA (dimethyl dodecyl), TOA (tri-n-octyl) and TDA (tri-n-dodecyl). (auth) (UK)

35916 TREATMENT OF NUCLEAR FUELS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,115,920. June 6, 1968. Priority date Aug. 8, 1964, Germany.

A method of separating nuclear fuels or of reprocessing irradiated nuclear fuels consists of reacting the fuel with a fused salt melt, maintaining the pH of the melt in the weakly acid to weakly basic range, separating the precipitate containing the fuel and fission products from the remaining melt by filtration of centrifugation, and treating the precipitate with dilute acid to dissolve the fuel and leave the fission products remaining as part of the residue. An oxide of N is introduced into the melt to maintain the pH, and the temperature of solidification of the oxidizing alkaline earth melt is adjusted by addition of varying amounts of one or more salts of Li, Na, and K. (B.L.M.)

35917 ON THE RETENTION BEHAVIOR OF ISOTOPE-CONTAINING COMPOUNDS BY APPLICATION OF AN ISOTOPE SCAN METHOD IN A COMBINATION OF CAPILLARY GAS CHROMATOGRAPHY AND MASS SPECTROSCOPY. Schomburg, G.; Henneberg, D. (Max-Planck-Institut fuer Kohlenforschung, Mulheim/Ruhr, Ger.). Chromatographia, No. 1/2, 23-31 (1968). (In German).

The separation efficiency of capillary columns (about) 100,000 effective theoretical plates for a 100 m, 0.25 mm id column) is sufficient for the separation of deuterium-labeled compounds from the corresponding unlabeled compounds. By means of the column D_2-labeled hydrocarbons can be separated completely from undeuterated molecules without difficulties. The separation efficiency is not sufficient for investigation of the influence of the positions of the deuterium atoms or the complete separation of $^{12}C/^{13}C$ or $^{10}B/^{11}B$ systems. By application of an isotope-scan method the profiles of overlapped peaks obtained from incomplete separations of isotopic molecules can be recognized. This can only be done using a capillary gas chromatography–mass spectrometer combination because of the very small influence of isotopic effects on the retention data. By this method orders of elution of molecules containing the different isotopes mentioned could be determined. (auth)

35918 RADIOCHEMISTRY OF THALLIUM. Kanapilly, George Mathew. Detroit, Wayne State Univ., 1964. 72p.

Thesis.

Several radioactive isotopes of thallium are known but thallium-204, with a half-life of 4.0 years, is the most important since other isotopes are of very short half-lives. These radiothallium isotopes are produced by the irradiation of mercury, gold, stable thallium, or occur as daughters of radioactive bismuth and lead during their decay. The study of the radiochemistry of thallium has been very limited and the need for the radiochemical procedures for thallium is great. Three different radiochemical separation procedures have been developed for thallium. The amalgam exchange separation of radiothallium was done in two steps; an exchange step and a back exchange step. The exchange step was done in the presence of fluoride ion or ethylenediamine solutions in the pH range of 6 to 11. In the back exchange step, the amalgam was diluted ten-fold with mercury and the exchanging medium was 0.1 M nitric acid. Isotopic exchange of radiothallium(I) and inactive thallium(III) hydroxide in the presence of fluoride or phosphate ions was studied. Citrate ion was added to the exchanging medium to eliminate the interferences of other cations, such as iron(III). The thallium(III) form of Amberlite-200 was used to separate radiothallium(I) ion from solution. The adsorbed radiothallium, along with the inactive thallium, was eluted using 6 M hydrochloric acid. Radioactivity of thallium was determined in all three cases by beta counting. (Disser. Abstr.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 35883 and 35964.

35919 (AECL–3022) PERCH LAKE EVAPORATION STUDY. Report of Progress to October 20, 1967. Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Oct. 1967. 27p. Dep. CFSTI. CAN $1.00.

The Perch Lake Evaporation Study was designed to evaluate the accuracy and usefulness of various evaporation measurement and estimation techniques by comparison with the tritiated (radioactive hydrogen) water flux from a small lake. The methods conventionally used to measure evaporation are summarized and the radioactive method is described. Also described are the changes that must be made to the lake and its immediate surroundings so that the relevant measurements could be undertaken. The parameters to be measured and a brief outline of the methods to be used are described. (auth)

35920 (BNWL–776) EVALUATION OF A THICK BASALT SEQUENCE IN SOUTH CENTRAL WASHINGTON: GEOPHYSICAL AND HYDROLOGICAL EXPLORATION OF THE RATTLESNAKE HILLS DEEP STRATIGRAPHIC TEST WELL. Raymond, J. R.; Tillson, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 127p. Dep. CFSTI.

The Rattlesnake Hills 10,655-foot deep stratigraphic test well located in south-central Washington state was re-entered, cleaned-out, and drilling fluid conditioned for in-hole geophysical examination and drill-stem testing. The objectives of the work were to evaluate the practicability of deep, subsurface disposal of radioactive wastes and to determine the physical properties of a portion of the Columbia River Basalt sequence that is not exposed for examination at other locations. Fossil dust assemblages recovered from coal cuttings between 2100 and 4800 feet offer evidence to support regional time-stratigraphic correlations proposed on the basis of chemical variations found. All the pollen evidence suggests a late Oligocene to early Miocene age (about 30 million years) which is generally considered as the beginning of the Columbia River Basalt. It was concluded that waste disposal by cavern or tunnel methods might be possible in some of the relatively unfractured basalt flows. Typical upper and mid-depth zones potentially suitable for such disposal occur at 1520, 2140, 2720, and 3200 feet below ground surface at the well site. (J.C.W.)

35921 (DP-MS–67-95) CONTRIBUTION OF TRITIATED WATER AT VARIOUS DEPTHS IN SOIL TO EVAPORATION AT THE SOIL SURFACE. Corey, J. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 10, 1968. Contract AT(07-2)-1. 24p. (CONF-680108–10). Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

Tritiated water deposited on the soil returns directly to the atmosphere by evaporation from the soil surface and by transpiration by plants. The time for tritiated water to evaporate from a loamy sand was measured when tritiated water was placed 0 to 14, 14 to 28, or 28 to 42 cm below the surface and for soil water contents of 0.05 and 0.10 g/g of oven-dry soil. The evaporation time increased with the depth of placement and with a decrease in water content. Tritiated water 14 to 28 cm below the soil surface did not evaporate before 60 hr. Tritiated water 28 to 42 cm below the soil did not evaporate before 200 hr from soil wet to 0.10 g/g of oven-dry soil, and not before 300 hr from soil wet to 0.05 g/g of oven-dry soil. (auth)

35922 (ISS-66/36) THE RADIOACTIVITY OF NATURAL WATERS. Biro, T. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Oct. 8, 1966. 65p. Dep.

An overall picture of radioactive contamination of natural waters is presented. Radionuclide distribution in different waters, measurement methods, and danger for population health due to the contamination are discussed. (auth)

35923 (NYO–2955-15) FIXATION OF ^{137}Cs BY SOIL CLAYS. Progress Report, 1962–1968. [Sawhney, B. L.] (Connecticut Agricultural Experiment Station, New Haven). June 30, 1968. Contract AT(30-1)-2955. 14p. Dep. CFSTI.

The sorption and fixation of Cs by different minerals in soil clays were established. In addition, it was demonstrated that in the absence of Al-interlayers, the sorption of Cs by soil clays was governed by the dominant clay mineral. Studies were also made on the time course of the sorption of Cs by illite, montmorillonite, and vermiculite saturated with Ca or K. Investigations on Cs sorption by biotite and vermiculite mixtures and the manner in which Cs collapsed vermiculite interlayers showed that the greater the amount of vermiculite, the greater was the Cs sorbed. Thus, the contention that the selective sorption of Cs was associated with a 10A spacing was found to be incorrect. Also, the selective sorption of illite and other weathered micas was found to be associated with their frayed edges rather than the 10A spacing. (P.C.H.)

35924 (ORO–490-15) RADIOACTIVITY TRANSPORT IN WATER: SIMULATION OF SUSTAINED RELEASES TO SELECTED RIVER ENVIRONMENTS. Shull, Roger Don; Gloyna, Earnest F. (Texas Univ., Austin. Environmental Health Engineering Research Lab.). [1968]. Contract AT(11-1)-490. 252p. (EHE–04-6801; CRWR–25). Dep. CFSTI.

The transport of radionuclides in rivers was simulated with a mathematical model. Large unregulated rivers receiving continuous normal waste discharges were studied with the model. The model included stochastic temporal flow variation, deterministic longitudinal flow variation, three-dimensional channel geometry variation with time and distance, generalized boundary sorption, boundary erosion, and flooding. Rivers of erratic flow, gradually varying flow, and nonvarying flow were studied. Hydrologic statistical variations in the system were examined. Effects of variations in radioactive half-life, surface concentration distribution coefficient, mass transfer coefficient, and sorption reversibility were also investigated. Variations in the mass transfer coefficient were not significant, but variations in surface concentration distribution coefficients were influential. On a long-term basis, flow variability had a significant effect on transport of short-lived radionuclides, but a negligible effect on transport of long-lived nuclides. Studies on continuous sedimentation zones indicated that significant quantities of long-lived radionuclides may accumulate therein. (auth)

35925 (ORNL-tr–1935) SURFACE METHOD OF MEASURING SNOW-WATER RESERVE USING SOIL RADIOACTIVITY. Zotimov, N. V. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Tr., Gos. Gidrol. Inst., 130: 148-62(1965). 21p. Dep. CFSTI.

This report was abstracted from the original language and appeared in NSA as 20: 43559. (R.C.K.)

35926 (PNE–1100) SEISMIC SITE CALIBRATION. Project PRE-GONDOLA. Kurtz, Maurice K. Jr.; Redpath, Bruce B. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Jan. 1968. 71p. Dep. CFSTI.

Measurements of intermediate range ground motions and of structural response were made during the Pre-Gondola high explosive cratering experiments at Fort Peck, Montana. Liquid nitromethane charges (1000-lb and 20-ton), emplaced at various depths of burst, and a 140-ton row charge were detonated in the Bearpaw shale, which is a weak, wet clay-shale medium. An additional experiment to validate a charge emplacement concept designed to decouple seismic energy proved inconclusive. All seismic measurements were of particle velocity. Using an inverse power law equation to describe the attenuation of seismic amplitudes with distance, it is found that the amplitudes from the single charges decayed as approximately $R^{-3.4}$, and amplitudes from the row charge decayed as $R^{-1.7}$. A dependence of amplitudes on depth of burst exists, and a yield scaling exponent near 0.8 appears to be appropriate. It is suggested that a variation of particle velocity with distance as $R^{-A}e^{-kfR}$, where f is the signal frequency, is a more physically realistic description of attenuation than is the inverse power law. The preliminary data from the 140-ton row charge appear to fit this type of attenuation law, and indicate that A = 0.5 and k = 0.015 sec/km. An estimate is made of the near-source variation of peak seismic amplitude with frequency for the row charge, and predictions are made for possible future row-charge cratering experiments at the site. (auth)

35927 (UCID–15233) GEOPHYSICAL MEASUREMENTS IN A LOW-DENSITY MEDIUM AT THE SCROLL SITE. Stearns, Ronald T.; Hearst, Joseph R. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 20, 1967. 40p. Dep. CFSTI.

Density and sonic velocity were measured in situ in a layer of low-density, highly incompetent tuff (ash flow) penetrated by the Scroll exploratory hole. Four methods were used to measure density, but because of the extreme rugosity and anomalous condition-of-the-hole at the ash flow, only the RIDL (Rugosity-Insensitive

Density Log) densities were considered satisfactory. The measured values of 1.41 and 1.43 g/cm^3 were well within expectations. Sonic velocities were measured by seismic-uphole and seismic-downhole methods. Velocities in the ash flow were greater than expected (6,700 ft/sec), and velocities in the denser medium above and below the ash flow were lower than expected (4,100 to 9,500 ft/sec). The high permeability of the ash flow material precluded filling the hole with fluid to obtain continuous, three-dimensional logs of sonic velocity. (auth)

35928 STABLE CARBON ISOTOPE RATIOS AS INDICES OF PETROCHEMICAL POLLUTION OF AQUATIC SYSTEM. Calder, John A.; Parker, Patrick L. (Univ. of Texas Marine Science Inst., Port Aransas). Environ. Sci. Technol., 2: 535-9(July 1968).

Variations in the ratio of stable isotopes ($^{13}C/^{12}C$) serve as a useful index of organic pollution of aquatic systems. Measurements were made on 15 water samples from the Houston (Tex.) Shipping Channel. From these data, a ratio that serves as a quantitative index of petrochemical pollution was prepared. Although the method gives no information about the chemical structure of organic pollution nor its toxic properties, the method is useful in providing insight into the overall carbon flux of large systems from relatively few and simple measurements. (auth)

35929 CONTRIBUTION TO THE TRACER KINETICS THEORY. Todorovic, P. (Univ. of Belgrade); Todorvic, Z. Int. Ass. Sci. Hydrol. Bull., 11: 111-21(Mar. 1966).

The radioactive tracer method is a technique for observing a set of specific labeled entities, such as molecules and particles of sand on the river bottom. In some instances kinetic studies may furnish information concerning processes of mixing, transport rates, and exchange. A theoretical basis is proposed for the study of the movement of a labeled particle which moves in random manner, from the random process point of view, and as a contribution to tracer kinetics theory. For hydrology, oil production, etc., it is very important to know the velocity and movement direction of ground water. Radioactive tracers may serve as a valuable tool in the analysis of ground water hydrology. An area of major contribution is the determination of the more fundamental properties of porous flow system such as porosity distribution stream function. Experimentally the radioactive tracer movement wave was followed by column methods. The most important fact in describing the movement of a radioactive tracer particle is that the motion is discontinuous. It is also important to assume that the motion is never upward. As the path of such a particle is in general a spatial curve and the distance traversed is of interest, the center of gravity of the particle was projected to the column axis. The projection also moves in a discontinual and random manner constantly in the same direction. (BBB)

35930 THE $^{230}Th/^{238}U$ METHOD FOR THE DATING OF STALACTITES AND STALAGMITES. Fornaca-Rinaldi, G. (Univ. of Pisa, Italy). Boll. Geofis. Teor. Appl., 10: 3-14(Mar. 1968). (In Italian).

The $^{230}Th/^{238}U$ ratio is suggested as a method for the determination of ages of stalactites and stalagmites. The technique consists of measuring the activities of Th isotopes belonging to the ^{238}U family, and comparing the activities with each other. The elementary theory of the method is developed, and from it limits for the application of the method are drawn. Illustrations show the handling of data for isotopes of ^{234}Th, ^{232}Th, and ^{230}Th. Actual samples from five sources are examples, samples in general being taken from external and internal layers and compared. Calculated ages vary between 15,500 and 78,500 yr. (BBB)

35931 NATURAL STRONTIUM IN THE CASPIAN SEA. Timoshchuk, V. I. (Kovalevskii Inst. of Biology of the Southern Seas, Sevastopol, USSR). Priroda, No. 1, 90(Jan. 1968). (In Russian).

Data were measured leading to the natural Sr levels throughout the Caspian Sea using samples 0 to 200 m below the surface, the biologically productive region. At the mouth of the Kura River the Sr level is 4.24 mg/l; other samples at the same latitude across the sea range upward to 17.16 mg/l. Across the central sea values range from 17.50 mg/l on the west coast down to 12.49 on the east coast. The east coast of the southern part has values ranging up to 25.30 mg/l. The upper sea (below the mouth of the Volga) has values from 13.00 to 15.41 mg/l. Thus content of Sr in the Caspian Sea is greater than that of the Indian and Atlantic Oceans as well as the Black and Aral Seas. Discussion of hydrochemical properties in light of these figures is given. (BBB)

35932 USE OF APATITE AND SPHENE FOR FISSION TRACK AGE DETERMINATIONS. Naeser, C. W. (Geological Survey, Menlo Park, Calif.). Geol. Soc. Amer., Bull., 78: 1523-6 (Dec. 1967).

The fission track technique is briefly described. These tracks of damage can be chemically etched so that they become visible through an optical microscope and are then counted to determine a spontaneous track density. The number of tracks is a function of the age of the sample and the amount of U present. The U concentration of the sample can also be determined by this technique. Since ^{235}U will fission when bombarded by thermal neutrons, the mineral sample may be irradiated in a reactor and then chemically etched before counting the new tracks. From the ratio of spontaneous to induced track densities the age can be determined. Fission track sample preparation techniques for sphene and apatite concentrates are discussed. Fission track ages were measured on 7 apatites and 2 sphenes from various igneous rocks. These were compared with other radiometric dates measured on these rocks, or with the expected geological age. In all but one case the fission track age, with its expected error, agreed with the other ages. The one sample not in agreement showed evidence of hydrothermal alteration. (BBB)

35933 DEVELOPMENT OF RADIOGEOLOGY IN USSR. Baranov, V. I. At. Energ. (USSR), 24: 419-21(May 1968). (In Russian).

For the last 50 years scientists of USSR have carried out work to evaluate the significance of radiogenic heat as a source of the internal energy of the Earth. The development of the work on the determination of the absolute age of geologic formations allowed to compile in USSR a geochronological scale and to introduce isotopic methods of dating into geological practice. Geochemical regularities of the distribution and concentration of radioactive elements have also been studied. (auth)

35934 INFLUENCE OF THE EFFECTIVE ATOMIC NUMBER Z_{eff} OF MINERAL DEPOSITS ON THE CONVERSION COEFFICIENT FOR DETERMINING POTASSIUM CONTENT BY THE METHOD OF GAMMA WELL LOGGING. Sen'ko, A. K.; Mishin, G. T. At. Energ. (USSR), 24: 96-8(Jan. 1968). (In Russian).

The dependence of the potassium conversion coefficient on the effective atomic number of the matrix material was investigated experimentally. The gamma emission of ^{40}K was counted, and a numerical value of the potassium conversion factor (μR-hr per 1% K) was calculated for a number of minerals varying from a 50% K content in a 96% KCl concentrate to a 5% K content in a sylvenite sample. The results showed that the value of the potassium conversion factor decreased with increasing Z_{eff} (from 2.67 in the 96% KCl concentrate with a Z_{eff} = 18.2 to 3.01 in potassium-containing clay with a Z_{eff} = 13.4). On applying the proper correction factor (depending on the value of Z_{eff}), it was possible to estimate potassium ore reserves more accurately. (TTT)

35935 EQUILIBRIA IN SYSTEMS CONTAINING URANIUM AND SULFIDES OF HEAVY METALS AT 200 TO 360°C. Rafal'skii, R. P.; Osipov, B. S. Geochem. Int. (Engl. Transl.), 4: 202-13(1967).

Experimental studies were made of the temperature effect on equilibrium concentrations of uranium, zinc, copper, and iron, in sulfate solutions in the presence of clayophane, marmatite, chalcopyrite, and galena at 200 to 360°C. It was established that relation between temperature and equilibrium concentrations of metals, as expressed in log $C_{Me} - 1/T°K$, is rectilinear. Equilibrium constants for reaction between uranyl sulfate solutions and clayophane, and that of clayophane dissolution in sulfuric acid, were calculated for temperatures of 200 to 360°C. An evaluation was made of ZnS solubility evolution at rising temperatures; it showed the existence of a maximum for the temperature–K_{ZnS} curve. The possible behavior of uranium and the principal heavy metals in hydrothermal solutions was considered at changing concentrations of hydrogen sulfide and the hydrogen ions. (D.L.C.)

35936 SHORT-LIVED RADIONUCLIDES AND WEATHERING. McCrone, Alistair W. (New York Univ., N. Y.). J. Sediment. Petrol., 38: 252-3(Mar. 1968).

The possibility of using short-lived radionuclides, constantly produced by cosmic ray spallation reactions in the atmosphere, to study the geochemistry of weathering over long periods of geologic time, is discussed. Rainfall carries these radionuclides to the ground where they enter into the geochemistry of weathering and early diagenesis. Even though their half-lives are very short, over millions of years tremendous quantities of these radionuclides must have reacted with rocks of the earth's crust. Thus, their cumulative effect in weathering, erosion, and redeposition of sedimentary materials must be much greater than yet imagined. Likewise, the contribution of cosmic dust, especially silicate dust, to sedimentary accumulations must be much larger than yet recognized. By serving for short times as trace element nutrients (e.g., ^{35}S, ^{38}S, ^{24}Na, ^{32}P, ^{33}P), in some of the major organic nutrient cycles, the nuclides may augment many organic geochemical

reactions that are critical in weathering. Many geochemical weathering reactions could be affected by the microenvironmental pH changes temporarily induced by rainfall charged with ^{35}S, ^{35}S, or ^{35}Cl ions. (BBB)

Meteorology

Refer also to abstracts 35882, 35957, and 36251.

35937 (AD-661249) EVALUATION OF FALLOUT CONTAMINATION FROM SURFACE RUNOFF. Final Technical Report, June 20, 1966-June 10, 1967. Grune, Werner N.; Atlas, Henry S.; Ruiz, Edward M. (Merrimack Coll., North Andover, Mass. Div. of Engineering). June 1967. Contract N00228-66-C-1606. 93p. CFSTI.

The initial stages in an investigation of factors affecting the transport of biologically important radionuclides into a reservoir by surface runoff are described. The phenomena of overland flow, infiltration, fallout deposition and activity transport have been analyzed separately and individual formulations for each have been derived. Computer solutions are presented. A general sketch of the projected overall model is reported. (auth)

35938 (AD-663103) NEUTRON-INDUCED ACTIVITY ON A BEACH: A METHOD FOR CALCULATING THE DOSE RATE. Read, Phillip A. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 28, 1967. 25p. (USNRDL-TR-67-133). CFSTI.

A method for calculating the dose rate above a beach from neutron-induced activity in the beach is presented. The gamma rays from the neutron-induced nuclides ^{24}Na, ^{56}Mn, and ^{28}Al are considered. The method can be used to consider cases involving nonuniform Na, Mn, and Al content and neutron thermalization in a beach. Results of calculations using the method are presented for typical cases. (USGRDR)

35939 (ANL-7429) RADIOIODINE MEASUREMENTS OF THE STACK EFFLUENT FROM THE CP-5 5.0-MW HEAVY-WATER REACTOR. Dillow, Weldon D. (Argonne National Lab., Ill.). Feb. 1968. Contract W-31-109-eng-38. 17p. Dep. CFSTI.

Experimental measurements and analyses of radioiodines in the stack effluent of the CP-5 Reactor are described. The objective of the study was the acquisition of data essential to analyzing the response of the present CP-5 iodine stack monitor and to determine the requirements of other permanent iodine monitors to be installed at various site locations. The following measurements and analyses were made: radioiodine collection efficiency of the Chicago Eye Shield Company's charcoal-loaded organic vapor respirator cartridge (CESCO); average ^{131}I and ^{133}I concentrations; ratios of ^{132}I, ^{133}I, ^{134}I, and ^{135}I relative to ^{131}I, based on analyses of scrubber samples; and analysis of the response of the present single-channel-analyzer (SCA) stack-monitoring system to a complex radioiodine spectrum. Results indicated that the CESCO cartridge is a satisfactory radioiodine collector with a collection efficiency of 92%. Average ^{131}I and ^{133}I stack concentrations ranged from 2.00 to 3.69×10^{-10} and 2.01 to 2.72×10^{-9} $\mu Ci/cm^3$, respectively. In only one of the four scrubber samples was ^{132}I positively identified. The $^{133}I/^{131}I$ ratios for operation at full reactor power determined from the scrubber samples ranged from 6.3 to 10.1, and were consistent with the ratios determined by charcoal-sampling techniques. The $^{134}I/^{131}I$ and $^{135}I/^{131}I$ ratios were more variable, varying by factors of three and two, respectively. Finally, the single-channel-analyzer response to ^{131}I was not singular, but was a multiple response to the other radioiodines as well as a result of their Compton continuum contributions to the ^{131}I photopeak. The ^{131}I contribution to the total count seen in the window of the single-channel analyzer was primarily a function of the sampling time, and could not be quantitatively determined during sample collection. (auth)

35940 (ANL/ES-CC-002) CITY OF CHICAGO AIR POLLUTION SYSTEM MODEL. Second Quarterly Progress Report, May 1968. Croke, E. J.; Carson, J. E.; Gatz, D. F.; Moses, H.; Clark, F. L.; Kennedy, A. S.; Gregory, J. A.; Roberts, J. J.; Carter, R. P.; Turner, D. B. (Argonne National Lab., Ill.). 160p. Dep. CFSTI.

Primary emphasis is placed upon the acquisition of air quality, meteorological and emission inventory data, and on the development of computational tools and analytical methods required to process, store, retrieve, and analyze data. The completion of the air pollution master information system—a set of linked computer programs designed to prepare and merge data files—was completed to search out and retrieve information from the files, to perform statistical analyses, and to display the results of computational studies and data surveys. This system is the basic tool required for the construction of the statistical SO_2 dispersion model. The diffusion analysis, meteorology emission inventory, and optimal abatement strategy phases of the program were achieved. These include a statistical study of the Hyde Park telemetry station air quality data; the completion of the St. Louis physical model development; the definition of preliminary meteorological, air pollution regime criteria; the acquisition, analysis and processing of a major segment of Chicago's power plant and industrial emission data, and the construction of an air pollution incident simulation code for the optimal abatement strategy study. Details of these and other studies conducted in support of the Chicago air pollution system analysis effort are discussed. (J.C.W.)

35941 (FOA-4-4351-28) FRAKTIONERINGSFENOMEN I EXPLOSIONSMOLNET. (Fractioning Phenomena in a Nuclear Explosion Cloud). Holmberg, B.; Andersson, S. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Apr. 1968. 28p. (In Swedish). Dep.

Fallout particles from tower and surface nuclear explosions are described. Their chemical composition and properties depend on the materials of the ground and the tower respectively and the amounts that are brought into the explosion cloud. Microsond analyses are compared for large particles from ground explosions and extremely small particles from both ground and tower explosions. The variation in composition depends on the phase diagrams of mixed oxides and are caused by fractionated condensation. Miller's, Freiling's, and Norman-Winchell's models for fractionation are discussed. Fractionation groups are deduced from experimental studies on volatile fission products reaction with refractory materials, their genetics and high temperature chemistry. (Sweden)

35942 (NYO-3654-4) NUMERICAL MODELS OF TRANSPORT, DIFFUSION, AND FALLOUT OF STRATOSPHERIC RADIOACTIVE MATERIAL. Final Report on Project STREAK. Seitz, Harold; Davidson, B.; Friend, J. P.; Feely, H. W. (Isotopes, Inc., Westwood, N. J.). May 31, 1968. Contract AT-(30-1)-3654. 103p. Dep. CFSTI.

A numerical model in two dimensions capable of simulating diffusion, mean circulation transport, particle fall velocity and tropospheric rainout is described. The model incorporates a general anisotropic diffusion process with the principal axis of diffusion oriented along lines of constant potential vorticity which are approximated to be parallel to the tropopause configuration. Rainout is simulated by the fractional removal of material at selected rain "formation" levels; the fraction removed at any latitude is proportional to the observed rainfall (climatological) at that latitude. The capability of the model has been extended by incorporating a four season variation of the meteorological parameters. Three major prediction experiments were conducted with the simulation of the following injections as initial conditions. The multiple injection of strontium-90 into the polar and tropical stratospheres by the 1961-1962, U.S.A. and U.S.S.R. nuclear test series. The observed mean stratospheric distribution of strontium-90 concentrations for January to April, 1964. The injection of tungsten-185 into the lower tropical stratosphere by the 1958 U.S.A. Hardtack test series. Model parameters were varied to achieve predictions which best reproduced the observed data of stratospheric transfer and surface deposition. Comparisons of model predictions with observed data are presented in detail. Consequences of inclusion in the model equation of mean meridional circulation terms derived from a "Brewer-Dobson" type circulation were investigated. The model was also used to obtain a prediction of the steady state concentration distribution of cosmogenic beryllium-7 resulting from the balance of cosmic-ray production, radioactive decay, eddy diffusion, particle settling, and wet removal. Also presented is the initial formulation of a theoretical model to determine the variation in the vertical of the size distribution of natural stratospheric aerosol. The model is one-dimensional and based on equilibrium between particle settling and vertical eddy diffusion. The basic design and simulation methods of the model prove to be sufficiently realistic to yield predictions in satisfactory agreement with observed data. (auth)

35943 (TLW-3803-1) FINAL REPORT OF STUDIES OF ^{238}Pu DEBRIS PARTICLES FROM THE SNAP-9A SATELLITE FAILURE OF 1964. Holland, Walter D. (Tracerlab/West, Richmond, Calif.). May 27, 1968. Contract AT(30-1)-3803. 44p. (TLW-6006). Dep. CFSTI.

A study was conducted on ablated ^{238}Pu particles from the SNAP-9A satellite failure of April, 1964, to provide data for the evaluation of the satellite re-entry burnup hazard. Two new techniques were developed: the thick-nuclear emulsion method for viewing the alpha tracks produced by alpha-emitting particles in LTA-ashed IPC paper; and the photoreversal technique for electron

microscopy of submicron radioactive particles. The size distribution of the ^{238}Pu particles after a one-month exposure in nuclear emulsion appears lognormal with a mode at ~13 mμ (particle diameter) and a size range of ~10 to 40 mμ. Scanning the sample slides after a one-year exposure confirmed the presence of many ^{238}Pu particles less than 10 mμ in diameter which were not seen in the one-month exposures. The contribution of Pu particles in the two- to five-track star region of the one-year-exposed samples is still unknown. Scanning slides with ^{238}Pu particles covered by nuclear emulsion also revealed that partial leaching (or dissolving) of these particles was occurring during the exposure period. A study of this effect indicated that as the equivalent $^{238}PuO_2$ particle diameter decreases, the percentage of the original particle leached increases. Since photoreversed particles were remaining on the microscope slides during float-off, three more efficient techniques for preparing these particles for electron microscopy were developed. When a suspension of ashed IPC, including ^{238}Pu particles in PVC (1%) was pipetted onto blank microscope slides; 65% of the particles remained with the PVC film segments during float-off. No calculations were made to determine possible loss to individual particles. Very thin PVC films were successfully fabricated; particles could then be sandwiched between two thin films to ensure complete encapsulation. The scanning electron microscope was used to view photoreversed weapon debris particles as small as 1 μ in diameter directly on the processed slides. All remaining portions of IPC were ashed; the ashed residue was covered with collodion (4%) and exposed to the scintillation-screen/x-ray film arrangement for 12 days. Two SNAP-9A particles were found, both with equivalent $^{238}PuO_2$ diameters greater than 50 mμ. An experiment with control slides to evaluate the scintillation-screen/thin-film nuclear emulsion arrangement in photoreversal studies showed no photoreversed areas indicating stars with more than six tracks. A second experiment with SNAP-9A particles was inconclusive because portions of the scintillation screen separated from the thin-film nuclear emulsion during exposure. Silicone oil on impactor slides was successfully diluted by a series of centrifugation-dilution steps. Electron microscopy of an aliquot from the fourth dilution showed no interference from silicone oil. (auth)

35944 (UCRL-50418) THE LONG RANGE DIFFUSION OF THE EFFLUENT CLOUD FROM THE PHOEBUS 1B EP-IV REACTOR TEST OF FEBRUARY 23, 1967. Crawford, Todd V. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 1968. 29p. Dep. CFSTI.

The movement and diffusion of the effluent cloud produced by the Phoebus 1 B EP-IV Event was tracked by aircraft for almost three days, and useful concentration measurements were obtained for almost two days. Pre- and post-run calculations were done with a computer code for large cloud diffusion using climatology and observed meteorology respectively. Calculations of concentrations and cloud size are compared with the available measurements. Calculations agree well with measurement for the first few hours. At later times, comparisons of measured and calculated concentrations and cloud size indicate that calculations yielded concentrations a factor of 2 to 5 higher than observed. The most likely explanation is the presence of a large amount of change with height through the depth of the cloud of the mean wind direction. The increased dilution rate due to this effect is not included in the calculational model. In this sense calculations will be conservative. A contributing cause of this difference may also be insufficient resolution in the aircraft data at late time. During the two days of interest, decay and diffusion decreased radioactive concentration more than eight orders of magnitude. (auth)

35945 INFLUENCES ON NATURAL RADIOACTIVITY IN THE LAYER OF AIR NEAR THE GROUND. Marquardt, W. Z. Meteorol., 19: 222-31(1967). (In German).

Some factors which influence the radioactivity of the near-ground layer of the air are discussed. The annual and diurnal variations of the natural total radioactivity and the diurnal variation of the thoron/Rn ratio are considered. A primary factor is the state of the ground at the observation point. Dry soil provides good soil respiration and, therefore, produces a high rate of contamination of near-ground air. Under moist soil conditions and especially with snow-covered ground there is a marked decrease of contamination. The annual variation of natural radioactivity is modified by the frequency of changes in the various states of the ground. Rapidly rising or falling atmospheric pressure via soil respiration also affects natural radioactivity; quantitative data can, however, not be detected. Owing to turbulent mixing, contamination of the air decreases with increasing wind velocity, enrichment of Rn and thoron secondary products being prevented, which has been confirmed by special measurements at various heights in Neuglobsow. With maritime air prevailing, lower concentrations are observed than with advection of continental air. Local effects may, however, be superposed. At mountain stations the influence of fog can be demonstrated. It is shown that local and meteorological factors do conspicuously affect contamination. Natural radioactivity may rise above the geologically expected value (e.g., Neuglobsow) or may remarkably decrease below the expected value (e.g., Mt. Brocken, Inselsberg). Measurements of natural radioactivity are not applicable to other places without major errors being introduced. (BBB)

35946 PURSUIT OF THE VERTICAL MOVEMENT BETWEEN 3000 AND 700 m ABOVE MEAN SEA LEVEL OF FALLOUT CLOUDS FROM THE CHINESE ATOMIC WEAPON TESTS OF 1966. Reiter, Reinhold (Physikalisch-Bioklimatische Forschungsstelle, Farmisch-Partenkirchen, Ger.). Meteorol. Rundsch., 21: 15-20 (Jan.-Feb. 1968). (In German).

Synchronous measurements of fallout radioactivity in the air and in precipitate matter were made at three mountain stations at 3000, 1800, and 700 m above mean sea level. These measurements permit early determination of fresh nuclear fission products carried by the advection layer, approximately one day to several days before their entry into lower levels, particularly populated regions. They also permit study of processes of transport in the lowest 2-km thick layer of air by following the fallout particles. The significance of atmospheric sinking processes, of turbulence and inversion in the two analyzed atmospheric layers is elucidated by means of movement diagrams and temperature probes. (BBB)

35947 INCREASED RADIOACTIVE FALLOUT IN STUTTGART-HOHENHEIM. Woerner, F. (Univ., Hohenheim, Ger.). Atomkernenergie, 13: 228(May-June 1968). (In German).

An increased radioactive fallout in Stuttgart-Hohenheim due to the Chinese nuclear weapon test on 24. 12. 1967 is reported. $1/t^n$-curves were evaluated and differences at the n-values also relative to the Chinese nuclear weapon test of 9. 5. 1966 are discussed. (auth)

35948 DISTRIBUTION OF ^{90}Sr AND ^{144}Ce IN THE STRATOSPHERE. Palmer, B. D.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Health Phys., 15: 31-6(July 1968).

Distribution of ^{90}Sr and ^{144}Ce in the stratosphere was investigated by analyzing high-altitude air filter samples collected in 1962 and 1963. The highest concentrations of ^{90}Sr (5.4 dis/man/SCF) and ^{144}Ce (122 dis/min/SCF) were observed in April 1963 at 64 to 70°N and at an altitude of 16.7 km. The $^{144}Ce/^{90}Sr$ ratio in the northern stratosphere was fairly constant (about 20, as of January 1963). The distribution patterns of ^{90}Sr and ^{144}Ce were quite different from those of ^{54}Mn and ^{124}Sb. (auth)

35949 SEASONAL VARIATIONS OF RADIUM-D (^{210}Pb) IN GROUND-LEVEL AIR IN INDIA. Joshi, L. U.; Mahadevan, T. N. (Bhabha Atomic Research Centre, Bombay). Health Phys., 15: 67-71(July 1968).

Measurements of ^{210}Pb concentrations in ground-level air at two stations in India, viz., Bombay and Srinagar, are presented. Sampling of the atmospheric particulates was done using Hollingsworth and Vose H-70 filter papers and powerful blowers. Radiochemical separation of ^{210}Pb from the air-filter collection was carried out after ashing of the filters at 250°C. The samples were counted in low-level end-window GM counters using the 1.17 MeV betas of daughter product ^{210}Bi both for activity estimation and for checking the radiochemical purity of the samples. The measurements at Bombay are from October 1961 to March 1966 and at Srinagar from March 1962 to March 1966. It was found that the activity concentrations varied from 6 μμCi/1000 m^3 to 60 μμCi/1000 m^3. A seasonal variation in concentrations, with maximum in winter and minimum in summer of each year, was observed. The likely causes for these variations and their differences with the seasonal variation of ^{137}Cs and other fission products are discussed. (auth)

Mineralogy and Exploration

35950 PROMETHIUM IN PITCHBLENDE. Attrep, Moses Jr.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 30: 699-703(May 1968).

A sample of pitchblende from Congo was found to contain $(4 \pm 1) \times 10^{-15}$ grams of ^{147}Pm per kg of ore. The $^{147}Pm/U$ ratio in the pitchblende was $(3 \pm 1) \times 10^{-4}$ disintegrations per second per gram of uranium. The observed $^{147}Pm/U$ ratio in the pitchblende was in agreement with the $^{147}Pm/U$ equilibrium ratio in non-irradiated natural uranium. The results indicate that the ^{147}Pm in African pitchblende is produced predominantly by ^{238}U spontaneous fission. (auth) (UK)

35951 RECENT GEOLOGICAL INVESTIGATIONS IN THE ELLIOT LAKE–BLIND RIVER URANIUM AREA, ONTARIO. Robertson, James A. (Ontario Dept. of Mines, Toronto). Can. Mining J., 88: 120-6(Apr. 1967).

Geological data and an inventory of U and Th deposits in the Elliot Lake area are presented. The U deposits are found as quartz-pebble pyritic conglomerate beds in zones controlled by basement topography. The uraniferous quartz-pebble conglomerate and green arkose sequence is characteristic of the Lower Mississagi Formation. The U mineralization is associated with whichever are the local basal beds of the Huronian sequence. Monazite and zircon are characteristic heavy minerals. Brannerite and uraninite are found in the matrix. Thucholite is found locally and may line fissures in the ore beds. The ore minerals are brannerite, uraninite, and monazite. The U–Th ratio is comparable to that of the basement. The lateral variation in the ore-mineral and U–Th ratios are best explained by the relative stability of monazite during transportation. Locally, individual conglomerate bands may assay as high as 20 lb or more U_3O_8 per ton, but over mining widths of the order of 9 to 30 ft average grade of those beds which are, or have been, mined is 2 to 3 lb U_3O_8 per ton. Probably the conglomerate accumulated as placer deposits derived from weathered red-phase Algoman granite and the U-bearing minerals were altered and redistributed during diagenesis, during the different periods of tectonic stress, and definitely during the introduction of diabase. Uranium production from the Blind River mining camp to the end of 1965 was 122,285,022 lb U_3O_8 valued at $1,161,211,459. Prospecting guides and methods are discussed as well as U–Th inventory and data processing. (BBB)

35952 URANIUM ORE DEPOSITIONAL EPOCHS. Yevstrakhin, V. A. (Ministry of Geology, Moscow). Izv. Akad. Nauk SSSR, Ser. Geol., No. 3, 13-27(Mar. 1967). (In Russian).

Several U depositional epochs are recognized (2000 to 1800 × 10^6 years, ca. 1200 × 10^6 years, 700 to 450 × 10^6 years, 320 to 200 × 10^6 years, and 130 to 50 × 10^6 years) in the past history of the earth. Several of these periods are planetary; the others are continental. Not less than 80 to 85% of U deposits occurred in the first and last of these epochs combined. The deposition process changes from geosynclinal to platform, from marine to continental; separation of U and Th occurs in the development of the outer geosphere in depositional processes. The role of hydrothermal U ore formation increases from the older epoch to the newer, the greatest contribution being in the most recent epoch. Tectonomagmate activation processes play an important part in the formation of many regions, so that poor mineralization regions may have economic concentrations of U ore. Formation processes of U mineralization become more diversified from older to newer epochs. (BBB)

Oceanography

Refer also to abstracts 36003 and 37625.

35953 (AED-C-25-02) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 25. MARITIME RADIOLOGIE. (Bibliographies in Nuclear Science and Technology. Section 25. Maritime Radiology). (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Apr. 1968. 43p. (In English and German). Dep.

A bibliography of maritime radiology including a listing of 119 items of conference papers, dissertations, reports, periodicals, and books is presented. (J.C.W.)

35954 STUDIES ON THE CHEMICAL BEHAVIOUR OF RADIONUCLIDES IN SEAWATER. I. GENERAL CONSIDERATIONS, AND STUDY OF PRECIPITATION OF TRACE AMOUNTS OF CHROMIUM, MANGANESE, IRON, COBALT, ZINC, AND CERIUM. Fukai, Rinnosuke; Lang, Huynh-ngoc (International Atomic Energy Authority, Monaco). Radioact. Sea, No. 22, 1-26(1968).

The results of experiments on the precipitation of chromium-51, manganese-54, iron-59, cobalt-60, zinc-65 and cerium-144 are discussed with a view to obtaining information on the characteristic precipitation pattern for each of the elements concerned in the initial period following its introduction into sea-water. The presence of soluble radioactive ferric iron may be negligible, although the possibility of ferric iron being introduced into the metabolism of marine organisms remains open. Radioactive chromium in the trivalent state may precipitate in the presence of iron hydroxide or other adsorbents, while in the hexavalent state it remains in solution under normal conditions; however, the stability of the latter is somewhat dependent on the organic substance content of the seawater. The co-precipitation of hexavalent chromium with barium sulfate may be negligible in the initial period. Radioactive manganese in the divalent state remains in solution throughout the initial period and will be taken up by marine organisms into their metabolic cycle. Most radioactive cobalt in the divalent state remains in solution and is available for the metabolism of marine organisms if no significant amount of manganese oxide is present in seawater. Although radioactive zinc will probably largely be lost from seawater in the initial period by adsorption onto the surface of adsorbents, an appreciable amount may remain in solution and be available for the metabolic cycle of marine organisms. Most of the radioactive cerium may be transformed into the solid phase, although it is possible that some may remain in solution for a fairly long time. The behavior of cerium is likely to depend on the state of dispersion at the time of its introduction. (J.C.W.)

35955 THE NATURAL RADIOACTIVITY OF SEDIMENTS OF THE BAY OF BANYULS. Got, Henri (Centre de Recherches de Sedimentologie Marine, Perpignan, France). Cah. Oceanogr., 20: 225-35(Mar. 1968). (In French).

Variations of radioactivity in sediments of the Bay of Banyuls are controlled by equilibrium between the fine clay fraction predominant in the sediments and the proportion of heavy minerals and micas, whose importance is a function of their proximity to the drift zones of the continents. Total activity is in general the result of natural radioactive minerals; but fission products are important. This latter activity is localized in fractions of lamellar minerals (clays, micas), which because of their structure favor fixation of artificial radionuclides. In all samples the levels are as follows: ^{232}Th, $^{234}U > ^{229}Th > ^{134}Cs$, $^{125}Sb \geq ^{40}K \geq ^{67}Zn$. In various samples (total, clays, sands, heavy minerals, micas) the ratio of fission products to ^{232}Th–^{234}U varied between 0.20 and 0.38; that of fission products to ^{229}Th between 0.44 and 1.07, the latter being a total sample; that of fission products to ^{40}K between 0.62 and 1.10. Analysis was performed by a 400-channel analyzer. (BBB)

Seismology

Refer also to abstract 35967.

35956 CONTROLLED BLASTING NEAR NUCLEAR REACTOR. Zenoble, Richard (Glasgow Inc., Glenside, Pa.). Civil Eng., 38: 68-9(Jan. 1968).

Conventional explosives and controlled blasting techniques which were combined to excavate 800,000 yd^3 of mica-schist without damage to a nearby nuclear reactor are described. At the Peach Bottom Atomic Power Station in York County, Pa., the excavation was needed to clear the way for erecting two nuclear reactors, at the site of an existing nuclear reactor, Peach Bottom No. 1. Controlled blasting, therefore, was necessary in preventing excessive vibrations that could damage the existing reactor. A system of blasting was developed for producing good rock fragmentation that did not disrupt operation of the nearby reactor. Near the existing reactor, blasting was regulated through the amount of explosives per delay. For example, a shot within 100 ft of the reactor contained 325 lb of explosives. In a single 3½-in. blast hole 24 ft deep this was all the explosive that could be fired with 1 delay. However, in areas a quarter of a mile away from the reactor, 500 lb per delay was permitted. By using up to 55 delays, each blast was allowed a gravity measurement of only 3.5%, which was recorded by 3 seismograph monitoring devices. The gravity criteria were exceeded twice, resulting in a temporary shutdown of the existing reactor. (BBB)

ENGINEERING

Nuclear Explosions

Refer also to abstract 37623.

35957 (AD-660655) FRACTIONATION VERSUS PARTICLE TYPE IN NUCLEAR SURFACE SHOT SMALL BOY. DIFFERENCES IN RADIOCHEMICAL COMPOSITION BETWEEN FRITTED AND SPHEROIDAL PARTICLES. Pascual, J. N.; Freiling, E. C. (Naval Radiological Defense Lab., San Francisco, Calif.). July 2, 1967. 20p. (USNRDL-TR-67-116). CFSTI.

Spheroidal and fritted particles of three size classes from close-in fallout samples collected from Small Boy were separated by hand. Analysis of spheroidal and fritted groups from the >1400 micron and the 350 to 700 micron size classes showed that spheroidal particles had higher specific activities than the fritted particles; however this difference was less pronounced for the smaller size groups. Contrary to reported observations on debris from a high-yield coral-surface burst, all groups showed comparable degrees of fractionation for radionuclides with rare-gas precursors. The Small Boy shot conditions were unique, however, and this homogeneity may not occur in more typical silicate-surface bursts. ^{106}Ru and ^{125}Sb were alike in behavior, but the data for these radionuclides do not correlate like those for rare-gas descendants. The necessity of adopting multidimensional correlations remains to be evaluated. (auth) (USGRDR)

35958 (AD-661451) HYDRODYNAMIC EFFECTS OF NUCLEAR EXPLOSIONS. VOLUME I. STATE OF THE ART. Final Report. Le Mehaute, B. J.; Whalin, R. W.; Koh, R. C. Y.; Hwang, L. S.; Webb, L. M. (National Engineering Science Co., Pasadena, Calif.). May 1966. 183p. (NESCO-S-244-1). CFSTI.

A compilation is presented of the theoretical and empirical methods of predicting the water waves and the run-up produced by explosions. The application of these theories requires the use of a succession of theories which are not necessarily mathematically compatible; a successful prediction is largely dependent upon the experience and physical intuition of the user. The many gaps in the theory and experimental results are delineated and areas requiring further study are pointed out. Explosions in deep water, the subsequent wave propagation characteristics and wave run-up are discussed. Also included is a section on water waves generated by air explosions over the adjacent land mass. General theories are proposed. The basic assumptions and the results of each theory were covered in detail. (USGRDR)

35959 (AD-661452) HYDRODYNAMIC EFFECTS OF NUCLEAR EXPLOSIONS. VOLUME III. APPLICATION CASES. Final Report. Le Mehaute, B. J.; Whalin, R. W.; Divoky, D. J. (National Engineering Science Co., Pasadena, Calif.). May 1966. 66p. (NESCO-S-244-3). CFSTI.

The state of the art of predicting explosion-generated water waves and their runup, was presented previously. The general conclusion was drawn that two extreme cases of coastal inundation threat exist. The first is that little danger exists for regions with a steeply rising shoreline adjacent to the broad expanse of relatively shallow water, e.g., on a bay, estuary, or wide continental shelf. Conversely, a threat does exist to areas with gentle beaches near deep water, e.g., at a very narrow continental shelf. These considerations are illustrated by application to two regions. (USGRDR)

35960 (AD-661453) HYDRODYNAMIC EFFECTS OF NUCLEAR EXPLOSIONS. VOLUME V. THEORETICAL DEVELOPMENTS. Final Report. Le Mehaute, B. J.; Koh, R. C. Y.; Hwang, L. S.; Mei, C. C.; Divoky, D. J. (National Engineering Science Co., Pasadena, Calif.). June 1966. 92p. (NESCO-S-244-5). CFSTI.

Waves resulting from the passage of a high-pressure disturbance over the free surface of a body of water are determined. This would occur in the case of a burst on or over land near a shore and is, therefore, of interest to the Five City Study in which three nuclear surface bursts are near rivers or bays. Motion of the ground water table induced by a surface burst is discussed. This problem is of interest for the determination of the migration of radioactive contaminants and is also applicable to three cities of the Five City Study. (USGRDR)

35961 (AD-661893) NUCLEAR WEAPONS AND THEIR DEFENSE. Chao, Chung-Yao; Ho, Che-Hui; Yang, Ch'eng-Tsung Yang. Translation of Yuan Tzu Neng Te Yuan Li Ho Ying Yung, Peking, 1965. 14p. (FTD-HT-66-422). CFSTI.

Explosive nuclear weapons such as atomic bombs, nuclear weapons made in the shape of bombs, shells, and missiles are discussed. The principle involved in their construction is the same throughout. Given in the article are diagrams of the structure of an atomic and hydrogen bomb, an atomic bomb containing atomic explosives in several separate piles, and a thermonuclear weapon. (USGRDR)

35962 (AD-663834) COMPUTER PROGRAM FOR THE DYNAMIC BLAST RESPONSE OF BOX-TYPE STRUCTURES. Final Report. Stubbs, Ian R.; Benuska, K. L. (Lin (T. Y.) and Associates, Van Nuys, Calif.). Dec. 1966. Contract OCD-PS-64-201. 117p. CFSTI.

Two digital computer programs are used to analyze the response of a multi-cell rectangular box-structure to external dynamic loads. The programs use the principle of finite elements to represent the box-structure and solve the equations of equilibrium by means of a Gaussian elimination procedure. The first of the two programs considers the dynamic response of the box-structure with its material properties remaining linear. The output consists of displacements, moments and stresses. Also, response spectra may be generated at equipment attachment points within the structure. The second program is used to calculate the dynamic response with the added provision that when moments in any plate exceed a predetermined yield value, that plate will not accept any increase in loads normal to its plane. However, it is assumed that the plate would still be able to carry the inplane diaphragm forces. A synoptic review pertaining to the failure modes and failure loadings of two-way slabs is presented. (USGRDR)

35963 (CGS-P-117) INVESTIGATION AND INSTRUMENTATION OF PANAMA AND COLOMBIA STRONG-MOTION SEISMOGRAPHS. (Coast and Geodetic Survey, Las Vegas, Nev. Special Projects Party). Sept. 20, 1967. 84p. Dep. CFSTI.

Strong-motion seismograph stations installed for the Inter-Oceanic Canal project in Colombia at Bogota, Cali, Medellin, Cartagena, and Barranquilla; and two stations located in Panama City were inspected. Three additional strong-motion seismograph stations were installed in the Colombian cities of Monteria, Manizales and Medellin. A preliminary seismic investigation in Colombia of the July 29, 1967 earthquake was made. (auth)

35964 (NVO-1229-85) MOVEMENT OF GASEOUS RADIONUCLIDES THROUGH GEOLOGIC MEDIA. Smith, Mary E.; Carnahan, C. L. (Isotopes, Inc., Palo Alto, Calif.). Feb. 1968. Contract AT(29-2)-1229. 60p. Dep. CFSTI.

Underground nuclear explosions result in formation of certain radioactive gases which might be transported away from an explosion zone and create possible hazards to ground water supplies. Study of normal diffusion, under the sole influence of concentration gradients, indicates that this mechanism may not be adequate to account for observed ground-surface concentrations of radioactive gases at short times after deeply buried detonations, but might cause contamination of distant ground waters at much later times, of the order of tens of years after detonation. Further theoretical study of diffusional transport mechanisms and certain laboratory and field investigations would be useful in elucidating the mechanism or mechanisms by which such gas transport is effected. (auth)

35965 (PNE-1102) PROJECT PRE-GONDOLA I. Technical Director's Summary Report. Final Report. Kurtz, Maurice K. Jr.; Christopher, W. G.; Day, W. C.; Fisher, P. R.; Harlan, R. W.; Redpath, B. B. (Army Engineer Nuclear Cratering Group, Livermore, Calif.); Chandler, J. C. (Army Engineer District, Omaha, Nebr.). Jan. 12, 1968. 141p. Dep. CFSTI.

The concepts, technical programs, objectives, and summarized results of Project Pre-Gondola I, a series of four 20-ton high explosive cratering experiments are reported. The experiments established the cratering characteristics of the weak, wet, clay-shale (Bearpaw) preparatory to row-charge cratering experiments. The results were used in the design of the 140-ton Pre-Gondola II row-charge cratering experiment detonated. The site medium, project layout, construction, field operations, and explosive charge design and emplacement are described. (J.C.W.)

35966 (UCRL-50419) COMPUTER CALCULATIONS OF THE GASBUGGY EVENT. Cherry, J. T.; Larson, D. B.; Rapp, E. G. (California Univ., Livermore. Lawrence Radiation Lab.). May 10, 1968. 11p. Dep. CFSTI.

Shock-wave effects calculations of the Gasbuggy gas stimulation experiment have been made using a one-dimensional Lagrangian code, SOC. The detailed material description used for the

equation of state of the rocks is presented along with the results of the calculations. Preliminary data from reentry of the emplacement hole indicate that the chimney height and available time of arrival data agree with predictions. (auth)

35967 (VUF-3012) FREE-FIELD PARTICLE MOTION FROM A NUCLEAR EXPLOSION IN SALT. PART I. PROJECT DRIBBLE, SALMON EVENT. Perret, William R. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. 257p. Dep. CFSTI.

The Salmon event of Project Dribble was a nuclear explosion of 5.3 kilotons equivalent TNT energy yield (2.23×10^{20} ergs), detonated at a depth of about 828 meters within the Tatum salt dome near Hattiesburg, Mississippi, on October 22, 1964. Instrumentation installed included accelerometers and particle velocity gages oriented to respond to vertical, true radial, horizontal-radial, and horizontal-tangential components of motion at four surface stations at horizontal ranges between 167 and 740 meters and in twelve subsurface stations within the salt at slant ranges between 166 and 744 meters at shot depth and at depths ranging between 220 meters above and 360 meters below shot level. Data were recorded from 49 subsurface and 16 surface gages. In addition, single integrations of six subsurface gages were recorded. Data derived from these records have been interpreted with the following results: sonic velocity in the salt is 4669 ± 25 meters per second; an elastic precursor wave of about 10 bars magnitude precedes a plastic wave of peak stress between 1.1 and 0.1 kilobars throughout the range of observations; particle velocity is attenuated as the inverse 1.87 power of slant range; reduced displacement potential peaks decreased monotonically from 5000 m^3 at 166 meters to 3700 m^3 at 744 meters range; essentially all of the ground motion energy derived from the Salmon explosion is propagated to a range of at least 660 meters by inelastic processes. Propagation at the remote station, 744 meters, may be elastic; special postshot-listening gages gave no evidence of cavity collapse, but signals in records from these gages included reflections from the Conrad and Mohorovicic discontinuities; fracture radius was found to be about 78 meters and open cavity radius was calculated to be 22 meters at about 2 seconds after detonation; and surface records indicate that spalling occurred at several depths of which the upper three are estimated to have occurred at about 4, 30, 77 meters below the surface. (auth)

35968 AN ANALYTICAL TECHNIQUE FOR URBAN CASUALTY ESTIMATION FROM MULTIPLE NUCLEAR WEAPONS. Hunter, Jeffrey J. (Research Triangle Inst., Research Triangle Park, N. C.). Oper. Res., 15: 1096-1108(Nov.-Dec. 1967).

For sensitivity analysis of national vulnerability assessment methods, an analytical technique was developed that estimates direct-effects casualties from multiple nuclear weapons. This is done by describing the urban population by a circularly symmetric density function. This density function may be readily varied to describe alternative shelter postures, movement to shelter away from city center, and for parametric analyses of many kinds. The input data are coordinates of the desired ground zeros and of the population center; weapon yields, burst heights, direct effects shielding, and corresponding casualty curves; circular error probability; and two areal population distribution parameters. Further generalizations involving extension of the model to consider elliptical normal population distributions, elliptical normal aiming error distributions, and modified casualty functions are also discussed. (BBB)

35969 THE NUCLEAR EXPLOSIVE, A POTENTIAL ASSET FOR CHEMICAL INDUSTRY. Cohen, P.; Dupuis, M.; Picq, J.-M. (Commissariat a l'Energie Atomique, Paris). Energ. Nucl. (Paris), 10: 224-30(May 1968). (In French).

Underground nuclear explosions release in surroundings a great amount of energy, resulting in a rise of temperature and pressure. Under these new conditions chemical reactions take place, leading, particularly, to gaseous products. The French nuclear tests in granite were considered to try to establish a method allowing determination of the quantitative and qualitative composition of the resulting gaseous mixtures. The method was extrapolated to oil shales. The radioactivity level is briefly considered. (auth)

35970 RAYLEIGH WAVE DISPERSION AND CRUSTAL STRUCTURE FROM RUSSIAN NUCLEAR EXPLOSION OF OCTOBER 30, 1961. De, U. S. Indian J. Meteorol. Geophys., 17: 475-6(1966).

Observations concerning the fundamental mode Rayleigh waves and earth crustal structure between Delhi and Novaya Zemyla are discussed. Comparisons of the group and phase velocities are presented relating the Rayleigh waves with theoretical Dorman case 8021 as a basis for a crustal model 35 to 40 km in thickness. The values obtained are considered closer to values for higher thicknesses. (J.R.D.)

35971 DYNAMICS OF INTENSE UNDERGROUND EXPLOSIONS. Cameron, I. G.; Scorgie, G. C. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Inst. Math. Appl., 4: 194-222(June 1968).

A mathematical model is described for computing the axially symmetric, unsteady, compressible motion of rock driven by an explosive deriving its energy from chemical or nuclear processes. The rock very near the explosive may be vaporized by shock heating, at somewhat greater distances it may be melted, and over a considerable range of distances it will remain solid, exhibiting a variety of responses largely dominated by elastic-plastic behavior beyond the scope of infinitesimal strain theory. Numerical tests of a Lagrangian-computer program are described, and an illustrative example discusses some aspects of an actual explosion of 500 tons of TNT for which observations have been reported. (auth)

Facilities and Equipment

Refer also to abstracts 35902, 36050, 36760, and 37632.

35972 (EUR-3901) CONVENZIONE EUREX EURATOM-C.N.E.N. RELAZIONE ANNUALE 1966. (Eurex EURATOM-CNEN Agreement. Annual Report, 1966). (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Apr. 1968. Contract 001-64-11 RCII. 42p. (In Italian). Dep.

The second year of work in connection with the construction, operation and use for industrial research purposes of the Eurex plant is described. Design and construction of the plant are described along with laboratory and pilot scale tests and experiments prior to the start of plant operation. Operation of the fuel element storage pool is also described. (auth)

35973 (LA-3862) PNEUMATIC SYSTEM FOR TRANSFERRING SAMPLES AUTOMATICALLY BETWEEN IRRADIATION AND DETECTION POSITIONS. Moore, B. M.; Ruess, H. M.; Swansen, J. E. (Los Alamos Scientific Lab., N. Mex.). Dec. 1967. Contract W-7405-eng-36. 7p. Dep. CFSTI.

A pneumatic system for transferring samples from a storage chamber to irradiation and detection stations and back to the storage chamber has been constructed. The mechanical, pneumatic, and electronic systems used are described. With this device, many samples can be irradiated and counted with little work on the part of the experimenter. (auth)

35974 (N-68-10050) COMPARISON OF LOAD BEARING AND NON-LOAD BEARING RADIATORS FOR NUCLEAR RANKINE SYSTEMS. Cockfield, R. D. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). May 6, 1967. Contract NASw-1449. 98p. (NASA-CR-72307; GE-ANSO-6300-203). CFSTI.

A comparison is made between load bearing radiators in a conical configuration, and nonload bearing radiators in a flat panel configuration, for a nuclear potassium Rankine powerplant. For a typical unmanned interplanetary probe mission the load bearing radiator showed a payload advantage of 4% at a power level of 300 kW(e), and an advantage of 30% at 1200 kW(e). The comparison shows that the nonload bearing radiator does not achieve the payload advantage for interplanetary missions that might be anticipated by virtue of its ability to dispose of launch structure. (auth)

35975 (NAA-SR-Memo-12367) CONCEPTUAL DESIGN FOR FAST FLUX TEST FACILITY MAINTENANCE AND DECONTAMINATION CELL. Burton, J. H.; Peckinpaugh, C. L. (Atomics International, Canoga Park, Calif.). July 27, 1967. 116p. Dep. CFSTI.

The M&D cell facility consists of four, independent, in-line cells. These cells are the transfer cell, inspection-cleaning cell, remote maintenance cell, and contact maintenance cell. The cells are positioned below the reactor operating floor level with individual vertical cell access provided with shield valves and/or sealed stepped plugs at all access ports. Each cell configuration provides a deep vertical maintenance area designed for specific maintenance functions. Transfer of components between each cell is provided with a components handling cask which operates outside the reactor containment in the building area above the M&D cells. The cask is similar to the components cask proposed for operation inside the reactor containment. (J.C.W.)

35976 (TID-24236) GLOVEBOX FIRE SAFETY: A GUIDE FOR SAFE PRACTICES IN DESIGN, PROTECTION, AND OPERATION. (Factory Mutual Research Corp., Norwood, Mass.). 1967. 133p. Dep. CFSTI.

Information is included on glovebox fire and explosion behavior, safety program administration, principles of glovebox construction, ventilation, fire detection systems, fire control within gloveboxes, and fire protection of rooms and buildings. Information is also

included on glovebox fires and explosions, high expansion foam generators, protection of closed containers against internal explosion, and criteria for fire tests. (J.R.D.)

35977 (UCRL-18185) CIRAN B LINEAR CIRCUIT-ANALYSIS PROGRAM: USER'S MANUAL. Tool, G. S.; Katz, Joseph E. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 15, 1968. Contract W-7405-eng-48. 21p. Dep. CFSTI.

CIRAN B is a computer program used to perform ac steady-state analysis and transient analysis of linear networks. The circuit schematic and analysis options are described to the program by means of the CIRAN B problem-description language. The problem-description language is a format-free means of describing a circuit-analysis problem in terms familiar to circuit designers. A report designed to serve as a user's manual for the CIRAN B program is presented. An example of a typical circuit-analysis problem is presented to illustrate the many conveniences built in to enable the user to rapidly describe his circuit analysis problem to the computer program. A means of obtaining graphical output which can superimpose related curves for variational analysis on the same frame is described and illustrated by the sample problem. (auth)

35978 PREPARATION FOR SMELTING OF METALS AND COMPOUNDS WITH HIGH MELTING POINTS. Himmelstein, Paul; Kuhn, Horst; Wille, Werner (to United States Atomic Energy Commission). U. S. Patent 3,391,238. July 2, 1968.

An arc furnace for melting materials of high melting point is described. The furnace comprises a crucible having a bottom portion insulated from the remainder of the crucible which serves as a lower electrode, an upper electrode mounted axially above the lower electrode, and a means for establishing an arc between the electrodes. A bottom electrode insulated in this manner aids in providing for a stabilized arc. (AEC)

35979 INSTALLATION FOR THE REMOTE CONTROL OF SAMPLES IN THE NEUTRON BEAM. Makhanov, U. M.; Nikolaev, M. N. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 17-20(Nov.-Dec. 1967). (In Russian).

A description is given of the mechanical installation and scheme for the remote control of samples in neutron beams with utilization of type-SHI-25/8 step selector, used during time-of-flight experiments with the fast beam of the IBR reactor. The installation was used for the remote control in neutron beams of different combinations of 15 samples of different thicknesses, previously arranged in drums, and for the production of signals on the position of the samples by appropriate codes. (tr-auth)

35980 ADJUSTING DEVICE FOR REMOTE CONTROL MANIPULATORS. (to United States Atomic Energy Commission). British Patent 1,114,915. May 22, 1968. Priority date Mar. 18, 1966, United States.

The design of a device for adjustably selecting a rest position of a slave unit in a tape driven remote control manipulator is given. The rest position spacing is between the fingers of a tape driven tong unit. (J.C.W.)

35981 RECENT DEVELOPMENTS IN EQUIPMENT AND TECHNIQUES FOR THE DETERMINATION OF HIGH-TEMPERATURE PHASE DIAGRAMS. Wallace, Terry C.; Rupert, George N.; Treiman, Leonard H. (Los Alamos Scientific Lab., N. Mex.). pp 17-31 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

Designs for eddy current concentrators and crucibles are given. High temperature thermal analysis instrumentation is described. Thermal analysis displays are described and the techniques are summarized. The use of the photon-counting pyrometer is outlined for analysis of the phase diagrams. (J.C.W.)

35982 ENERGY SOURCE APPARATUS. (to Atomic Energy of Canada Ltd.). British Patent 1,113,766. May 15, 1968. Priority date Feb. 1, 1965, Canada.

The design of an energy source includes a series of radioactive pencils mounted in a frame. An apparatus moves the frame and pencils between an irradiating position and a storage position, and a track shaped such that the framework takes an annular form at the irradiating position. It takes a planar form moving from the irradiating to storage positions. (J.C.W.)

35983 RADIATION UNIT WITH 1200 Ci ^{60}Co AND 240 Ci ^{137}Cs. Klumpar, Josef; Jirousek, Pavel (Inst. of Nuclear Research, Prague). Jad. Energ., 14: 134-6(Apr. 1968). (In Czech).

An arrangement containing 1200 Ci ^{60}Co and 240 Ci ^{137}Cs designed for the realization of absolutely standardized collimated narrow beams of gamma radiation is described. Besides details about the construction and arrangement of the containers, the delayed control of the beams and the electrical and mechanical safety devices, the results of measurements characterizing the ^{60}Co beam and isodoses of the radiation field inside the room with open ^{60}Co beam are given. (auth)

35984 THERMAL NEUTRON TELEVISION SYSTEM USING A HIGH YIELD NEUTRON GENERATOR. Kawasaki, S. (Tokyo Shibaura Electric Co., Ltd.). Nucl. Instrum. Methods, 62: 311-15(July 1, 1968).

A thermal neutron television system using a high yield neutron generator has been developed and has made possible to get thermal neutron images with a closed circuit television system. This system consists of a 10^{11} neutrons/sec neutron generator having an improved rf ion source and a thermal neutron image intensifier in which the thermal neutrons of 10^4 n/cm^2·sec are transformed into an optical signal of about 500 1×. The characteristics of the improved rf ion source for a high yield neutron generator and the thermal neutron image intensifier are discussed and the thermal neutron television images of the water flow in a copper tube are demonstrated. (auth)

35985 THE ESTIMATED DEMAND FOR SEPARATIVE WORK FOR THE ENRICHMENT OF URANIUM IN THE FRG. Boettcher, A.; Kraemer, H.; Wagemann, K. (Kernforschungsanlage, Julich, Ger.). Atomwirt. Atomtech., 10: 249-55(May 1968). (In German).

An investigation into the probable demand for separative work for the enrichment of uranium in the German Federal Republic has been carried out. Model calculations related to reactor types installed extend to the year 2000. The probable size of the separation capacity required is calculated. Investigated was the demand of the conventional power stations, light water reactors, and fast sodium breeders with oxide fuel. Since the breeders are dependent upon the plutonium produced in the light water reactors, the influence of fast converter reactors running on enriched uranium, as suppliers of plutonium, was also investigated. This permitted, from the aspect of fuel supply, an essentially more rapid advance of the fast breeder. The introduction of heavy water reactors into the system offered considerable advantage for the supply of plutonium to fast breeders. A lowering of the total demand for separative work during the period, in which the fast breeder will still not have attained a large share in power production, is to be expected from the introduction of thorium, high-temperature reactors into the system. The demand will be particularly low if fast breeders with carbide fuels and thorium, high-temperature reactors with beryllium oxide moderators could be introduced. The additional adoption of heavy-water reactors would offer an economic advantage with this system only if the separation work should prove very costly. (auth)

35986 CHEMICAL INDUSTRY AND NUCLEAR ENERGY IN FRANCE. Regnaut, P. (Commissariat a l'Energie Atomique, Paris). Atomwirt. Atomtech., 10: 256(May 1968). (In German).

The chemical industry in France was drawn very early, about twenty years ago, into work connected with the development of nuclear energy. In the first five years research work predominated being followed by a period of expansion through intensified industrial participation in the building of experimental and production plants and through the supply of nuclear materials and products. The main fields of activity of the French chemical industry are the development and manufacture of uranium, plutonium, and reactor materials such as graphite, heavy water, organic moderators, and cooling media as well as hafnium-free zirconium. In addition this branch of industry has, directly and indirectly, made important contributions to many other nuclear developments, e.g., to the isotope separation plant in Pierrelatte for manufacture of UF_6, separation membranes, and fluorine technology. Even if the large constructional projects of the first period are now finished the upsurge in nuclear energy with the growing demand for nuclear fuels and reprocessing capacity offers good future prospects as well as new problems. A future advance is also to be expected in the other nuclear areas which do not serve energy generation, e.g., the application of isotopes and the use of radiation. The most important applications of nuclear energy on the chemical industry lie in these areas, e.g., activation analysis, tracer isotopes, and radiation chemistry. It is also to be expected that chemistry can make interesting proposals for the direct utilization of power reactors in the form of multi-purpose reactors. The French chemical industry can also gather the fruits of twenty years' development in the form of growing export contracts. (auth)

35987 WELDED TUBES FOR FUEL ASSEMBLIES. Salmon, Benjamin T. (Carpenter Steel Co., San Diego, Calif.). Power Eng., 72: No. 7, 44-5(July 1968).

The advantages of welded tubes for reactor fuel assemblies are discussed. These advantages include more uniform wall thickness, clean tube wall surfaces, and fabrication versatility. Economic advantages are also realized due to the uniformity of welded tube walls which permits the design of tubes with less weight of metal. (R.C.K.)

35988 MOTOR-DRIVEN MANIPULATING DEVICE. Matsumoto, Aribumi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-17919. Oct. 17, 1967. Filed June 17, 1963.

A motor-driven manipulating device is described in which the slave fingers can be detached from or fixed onto the wrist by a remote motor. The manipulator is movable in all directions in the shielded cell. The operation console is outside the cell and an outer frame is at the wrist. A support cylinder, installed rotatable inside the outer frame, and a manipulating rod, installed axially movable inside the support cylinder are included. The base of fingers, with a mechanism which engages with or disengages from the support cylinder according to the rotation position with the support rod as the center is given in the design. A rack bar engages with the pinion to open or close the fingers with a mechanism, which engages with or disengages from the manipulating rod according to its rotation position. A cylinder, installed movable axially, prevents the mutual rotation of the support cylinder and fingers base when it engages to the (fingers) base (by spring), and permits the rotation when the engagement is released by means of the finger-tips holder. An electric motor rotates the support cylinder, operated from the console. (NSA of Japan)

35989 BENCH FOR TAKING SAMPLES OF LIQUIDS AND IN PARTICULAR RADIOACTIVE LIQUIDS. Conche, Francois; Duboz, Jacques; Guilloteau, Rene; Pillerault, Jean (to Commissariat a l'Energie Atomique). U. S. Patent 3,383,923. May 21, 1968. Priority date Apr. 20, 1964, France.

A liquid sampling apparatus for obtaining samples from plural liquid sources is described. A centrally located enclosed chamber is provided with plural hollow needles extending into each, communicating with a separate source of liquid. A manipulative means extending into the chamber is provided for removing a cover from the needle, supplying a series of sample bottles each sealed with a rubber plug, evacuating the bottles, empaling the rubber plugs of the bottles upon the needles for taking the samples and subsequently rinsing the needles before returning their covers. (auth)

Heat Transfer and Fluid Flow

Refer also to abstract 35974.

35990 (NYO-3304-12) INVESTIGATION OF BOILING FLOW REGIMES AND CRITICAL HEAT FLUX. Quarterly Progress Report, September 16, 1967–March 15, 1968. Report No. 783. Bergles, A. E.; Roos, J. P. (Dynatech Corp., Cambridge, Mass.). May 1968. Contract AT(30-1)-3304. 34p. Dep. CFSTI.

The design and construction of the electrically heated four-rod bundle test section is presented. A four-channel burnout protection system and an array of three electrical probes were developed for this test section. The test section and instrumentation performed satisfactorily under adiabatic and diabatic conditions. Detailed adiabatic flow regime maps were developed for the central subchannel and a corner subchannel. At a given operating point, different flow regimes were frequently observed in these subchannels, with the corner subchannel exhibiting a lower void fraction regime than the central subchannel. This is indicative of a channeling of the vapor into the less restricted subchannel. Heating is shown to produce significant shifts in the flow regime boundaries. Adiabatic film thickness measurements at a particular location indicate the usual trends of decreasing thickness with increasing quality and mass velocity. Thickest films were observed on the shroud, while the film on a rod in the interior subchannel was consistently thinner than that on the rod in the corner subchannel. The rod films are considerably thinner with heating, and it appears that the dryout condition was initiated in the interior subchannel. The burnout data are in reasonable agreement with available data for similar flow conditions; however, a definite comparison cannot be made due to the different geometrical arrangements. (auth)

35991 (RT/ING-(67)15) ASPETTI FONDAMENTALI DELL'EBOLLIZIONE. (Fundamental Aspects of Boiling Phenomena). Cumo, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 236p. (In Italian). Dep.

The systematic employment of dimensional analysis throughout the various aspects of boiling phenomena supports an organized view in which are inserted experimental results from many laboratories. Whenever possible, well-known theoretical procedures are adopted which best explained particular boiling aspects. (auth)

35992 (SAN-677-25) INVESTIGATION OF FUNDAMENTAL MECHANISMS AND PARAMETERS THAT INFLUENCE STEADY STATE AND TRANSIENT PERFORMANCE OF RANKINE CYCLE LIQUID METAL SYSTEMS. Biannual Report, October 1, 1967–March 31, 1968. Poppendiek, H. F.; Greene, N. D.; Goddard, W. B.; Sabin, C. M. (Geoscience Ltd., Solana Beach, Calif.). Contract AT(04-3)-677. 31p. (GLR-62). Dep. CFSTI.

Research activities on phase distributions in forced flow boiling applicable to Rankine cycle systems is reported. A microscopic photographic system has been designed and constructed for use in boiling mercury phase distribution research. Magnifications from 2.5 to 20X are available with both high speed Polaroid and 35 mm exposures; higher amplifications are achievable through a projection magnifier. Timing circuits have been developed which also allow mercury droplet velocities to be deduced. Photographs of two phase, gas-mercury flow have been obtained with the microscopic photographic system. Phase distributions of mercury from zero to 50% equivalent vapor qualities have been photographed within a transparent $\frac{3}{8}$ inch boiler tube in a low temperature, recirculating system. The satisfactory operation of the phase distribution system, conductance measurements, and photographs of phase distributions have been made for helical, forced flow mercury boiling. (auth)

35993 SODIUM BOILING HEAT TRANSFER IN CONDITIONS OF NATURAL CONVECTION. Subbotin, V. I.; Ovechkin, D. M.; Sorokin, D. N.; Kudryavtsev, A. P. At. Energ. (USSR), 24: 437-42(May 1968). (In Russian).

Experimental data on sodium boiling heat transfer in natural convection conditions are examined. It was shown that at the liquid bulk temperatures which are equal or exceed saturation temperatures there are heat removal conditions such as heat removal at developed boiling; heat removal at unstable boiling; and heat removal of high heat fluxes ($\sim 10^6$ w/m^2) by convection with further heat removal when evaporating from a free surface. The presence of one or another heat removal depends on pressure level, heat flux quantity, heat transfer surface state, and other factors. At developed sodium boiling under the pressure of ~0.05 to 0.3 bar available data can be expressed by $\alpha = 8.5q^{2/3}p^{0.4}$ w/m^2 grad and under the pressure of ~0.3-1 bar by $\alpha = 6q^{2/3}p^{0.1}$ w/m^2 grad. At unstable boiling which is characterized with large fluctuations of heat transfer wall temperature, time-averaged heat transfer coefficient values α are between α values for developed boiling and for heat removal by convection. Experimental data on sodium boiling are compared with generalized formulas for calculation of boiling heat transfer coefficients. (auth)

35994 SUPERHEATING AND SINGLE BUBBLE EJECTION OF STAGNANT SODIUM. Spiller, K.-H.; Perschke, D.; Grass, G. (EURATOM, Ispra, Italy). Atomkernenergie, 13: 245-51(1968). (In German).

To provide information with regard to the safety of sodium cooled fast-breeders, stagnant sodium in a vertical tube of 7 mm inner diameter was directly heated by a direct current. The superheat and the kinetic behavior at the onset of boiling were recorded. The temperature, velocity, acceleration, and pressure at the column of liquid metal were measured and the length of the vapor bubble as well as the recondensation phenomenon were investigated. Superheats were measured from 0 to 330°C. At a saturation temperature of 900°C, the average of the measured superheats increased from 69°C at the sixteenth day after filling of the equipment to 218°C at the twenty-ninth day. It was observed that the expansion velocities of the vapor bubble could reach values up to 19.7 m/sec (mostly 3.5 to 7 m/sec) and that the maximums of acceleration amounted to 1400 m/sec^2 (mostly 100 to 500 m/sec^2). Pressure peaks at recondensation reached maximum values of 27 atm-abs (mostly 16 to 22 atm-abs) and those at explosion of 11 atm-abs (mostly 1.5 to 3.5 atm-abs). The maximum vapor bubble length amounted to 1024 mm when the heating length was 20 mm. The most frequently measured bubble length was found to lie between 160 and 430 mm at a high saturation point and between 430 and 1024 mm at a low saturation point with high superheating. The heating rate corresponded to a temperature of 19 to 47°C/sec. (auth)

35995 A THEORETICAL APPROACH TO THE ANALYSIS OF AN ADIABATIC TWO-PHASE ANNULAR DISPERSED FLOW. Biasi, L. (Univ., Milan); Clerici, G. C.; Sala, R.; Tozzi, A. Energ. Nucl. (Milan), 15: 396-407(June 1968).

A theoretical study on adiabatic two-phase annular dispersed flow is presented. Starting from the knowledge of the total pressure drop and the average void fraction, an equation relating the liquid film thickness to the system parameters is obtained. The

liquid and gas film flowrates are also given. A comparison with some experimental data is also included. (auth)

Isotope Technology

Refer also to abstracts 35943 and 37211.

35996 (AD-662192) ESTIMATING STRENGTHS OF INDIVIDUAL RADIOISOTOPES IN A MULTIPLE-ISOTOPE SOURCE. Eaton, M. L.; Wilcoxson, W. L. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Nov. 1967. 87p. (NCEL-TR-551). CFSTI.

In work related to radiation shielding, the use of radioisotope techniques, and activation analysis, an experimenter must often analyze counting data where counts are caused by the natural background and by the decay of more than one radioisotope. A procedure is described for estimating the strength of each isotope at different times from several decaying radioactive samples of a single multiple isotope source. In addition, the procedure provides a method for placing confidence limits on the strengths and a method for partitioning the imprecision of estimating the strenghs into three principal causes: Poisson variation, sampling error, and residual error (called mechanical error). An operational FORTRAN 11-D computer program, SAND, implements the procedure. The procedure and program were tested by using fictitious data with known properties as inputs. The results of the simulation were in reasonable agreement with the theoretical values. (USGRDR)

35997 (AD-663349) DYNAMIC DECOMPENSATION OF THE SPACE CHARGE OF ION BEAMS DURING ELECTROMAGNETIC SEPARATION OF ISOTOPES. Gavrilov, B. E.; Zharinov, A. V.; Raiko, V. I. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated from report IAE-592. 16p. (FTD-MT-66-148). CFSTI.

An attempt is made at an elementary theoretical generalization of certain properties of intense ion beams, primarily for the purpose of finding possible methods of controlling dynamic decompensation. It is shown that the geometrical properties of beams extracted from plasma obey the laws of similarity. On the basis of these laws, general relationships are established which correlate the plasma density pulsations in the source, the angular divergence, the degree of dynamic decompensation, and the beam potential. The elementary theoretical analysis used shows that the regimes most favorable from the standpoint of dynamic decompensation of ion beams are those corresponding to divergent beams. Under these conditions, the degree of dynamic decompensation is minimal and is the same in order of magnitude as the relative pulsation of plasma density in the discharge. Therefore, since it is always possible to select regimes where the pulsations of angular divergence become unimportant, a further increase in the intensity of compensated ion beams will require the development of methods for substantially decreasing the level of current density pulsations in the discharge. (USGRDR)

35998 (ISS-68/6) INTRODUZIONE ALLA FISICA DELLE RADIAZIONI. CAPITOLO VII. (Introduction to Radiation Physics. Chapter VII. Amaldi, U. Jr. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Feb. 21, 1968. 78p. (In Italian). Dep.

This is the seventh of the series of reports on the lectures on Radiation Physics held at the "Scuola di Specializzazione in Radiologia Medica dell'Università di Romà." This issue is devoted to the description of radiation sources, in particular, to radioactive sources, x-ray units, and betatrons. In the last section, other particle accelerators of radiological use are briefly described. (auth)

35999 (KFK-702) PLANUNG UND BAU EINER 10-STUFIGEN PILOTANLAGE FUER DAS TRENNDUESENVERFAHREN. (Planning and Construction of a 10-Stage Pilot Plant for the Nozzle Separation Method). Becker, E. W.; Frey, G.; Schuette, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernverfahrenstechnik). Feb. 1968. 46p. (In German). Dep.

Thesis. Submitted by G. Frey to Technische Hochschule, Karlsruhe, Ger.

The nozzle separation method uses the partial spatial separation of various heavy components of a gas mixture in an expanding ultrasonic beam for isotope separation. The planning and construction of a 10-stage pilot plant for separation of uranium isotopes is described in detail. The nozzle separation cascade, the UF_6 separation installation, the vacuum system, and the antiresonant power supply of the condenser are each discussed. The present status of the planning and construction is outlined. (J.S.R.)

36000 (MMM-3691-30) SNAP-21 PROGRAM, PHASE II, DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM. Quarterly Report No. 7, January 1–March 31, 1968. Fox, F.; Herrlich, R. (Minnesota Mining and Mfg. Co., St. Paul). Apr. 1968. Contract AT(30-1)-3691. 227p. Dep. CFSTI.

SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-21)—power supply system for, design and testing of
FUEL CAPSULES—design, fabrication, and testing of SNAP-21
SHIELDING—testing of biological, for SNAP-21
THERMAL INSULATION—development and testing of SNAP-21
THERMOELECTRIC CELLS—components for SNAP-21, design and development of
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-21)—thermoelectric generator for, shock and vibration testing of
PRESSURE VESSELS—fabrication and testing of SNAP-21
SAFETY—analysis and testing of SNAP-21 (R.C.K.)

36001 (MMM-3824-0020) SNAP-23A PROGRAM, PHASE I, THERMOELECTRIC CONVERTER DEVELOPMENT PROGRAM. Quarterly Report No. 5, January 1–March 31, 1968. Wachenheim, J. V. (Minnesota Mining and Manufacturing Co., St. Paul). Contract AT(30-1)-3824. 152p. Dep. CFSTI.

During the quarter, fabrication of Experimental Mockup Converters (EMC's) Nos. 2 and 3 was completed; EMC No. 1 was integrated into EMS No. 1; EMC No. 2 completed short-term testing and successfully underwent dynamic testing; and EMC No. 3 completed short-term testing. Experimental Mockup Converter No. 3 has been modified which resulted in improved power output, efficiency, and heat transfer characteristics. These modifications consisted of changing the basic thermocouple design configuration to include bonded type P-legs (rather than the simultaneously pressed P-legs used in EMC Nos. 1 and 2), and addition of indium foil at the cold cap-to-follower spherical interface to reduce the temperature differential. Analysis of data from tests conducted up to this time indicates that the converter performance is significantly better than EMC Nos. 1 and 2 (7.43% overall efficiency at EOL conditions for EMC No. 3 as opposed to 7.0% for EMC No. 2). In addition, the cold side temperature differential for EMC No. 3 is 21°F versus 45°F for EMC No. 2 and 47°F for EMC No. 1. This value is within the required 30°F maximum average. Efforts for the Prototype Mockup Converter (PMC) were decelerated from those originally planned due to a combination of factors including the unavailability of EMS No. 1 system data, and the decision to wait until EMC No. 3 test data could be included in the PMC design base. Agreement was reached to the effect that the nominal interface dimensions for PMC No. 1 will be the same as those for EMC No. 1. A comprehensive review of the proposed design data base, the design approach, and the final design details was held. Long-term testing of 10-couple modules 1 through 8 was continued and long-term testing of modules 9 through 12 was initiated. The first statistical analysis of the data taken for modules 5 through 12 was completed, and data through the 1000-hour point is presented. Other significant accomplishments are summarized as follows: an improved PMC thermocouple weld technique was developed; bell jar beryllium oxide (BeO) follower cold-end heat transfer evaluation tests were conducted; 10-couple module and bell jar test data were updated to include the "new" material characterizations; and SNAP-23 P-2 converter were refurbished and placed back on long-term test. (auth)

36002 (NUMEC-3731-13) RADIOISOTOPE-POWERED CARDIAC PACEMAKER PROGRAM. Mid-Term Report, Phase I. (Nuclear Materials and Equipment Corp., Apollo, Pa. Energy Conversion Div.). Apr. 19, 1968. Contract AT(30-1)-3731. 156p. Dep. CFSTI.

The results of developmental work on the Radioisotope-Powered Cardiac Pacemaker (RPCP) are reported. The objectives of the program are to design a safe, reliable, and long-lasting RPCP system; develop all components (except pacemaker electronics and heart electrode) including analysis, design and testing; fabricate, assemble, and test electrically heated and radioisotope fueled prototype systems; conduct a comprehensive safety analysis; and to prepare a comprehensive development plan including a reliability and quality assurance program. Accomplishments include the completion and performance testing of a mockup assembly; the development of analytical techniques for the RPCP system design; basic material property measurements to measure the critical material properties over a wide range of temperature in vacuum; and system analysis to determine potential reliability. (R.C.K.)

36003 RADIOTRACER DISPERSION STUDIES IN THE VICINITY OF A SEA OUTFALL. Barrett, M. J.; Munro, D.; Agg, A. R. Water Res., 2: 124-6 (Jan. 1968).

Methods employing a radioisotope (^{82}Br) to trace dispersal of sewage discharged into the sea are reported. Some physical aspects of the problem were studied, including dispersion in the top

2 m in an unstratified coastal water, up to 15 m deep, and at distances up to 1 km offshore. To study the dispersion, a solution containing a few hundred mCi of ^{82}Br was added instantaneously to the sea surface and the activity was tracked at 3 depths for several hours. At intervals following the addition of ^{82}Br, the distribution of radioactivity was determined at depths of 0.3, 1, and 2 m by traversing the active area systematically in a boat towing submersible streamlined vessels containing γ scintillation counters. A visual indication of the concentration of activity was provided by logarithmic rate meters and a continuous record of the concentration was obtained by recording the pulses on 8-channel magnetic tape. A set of contours is shown for the distribution of activity, at depths of 0.3, 1 and 2 m below the surface, 148 min after the addition of 300 mCi to the vicinity of the sewage outflow. An analysis was carried out on some of the processed data, with the assumptions that the dispersion is chiefly a result of horizontally isotropic turbulent diffusion. If it is assumed that diffusivity is proportional to some power of the distance, r, from the center of the patch and some power of the time, t, that has elapsed since the patch was a point then the differential equation of diffusion has an analytic solution, in two dimensions, of the form: $C(r,t) = C(o,t) \exp(-ar^n/t^m)$, where C(r,t) represents concentration at distance r from the point of maximum concentration at time t, and a, m, and n are independent of r and t. At each depth, for each time, t, that a patch was plotted, an average radius was found for each contour from its area. The maximum concentration C(o,t) was taken as the observed maximum concentration. These measurements were used in various combinations to solve this equation by partial regression analysis for m and n. The calculated values of m and n lie within the range suggested in other studies. (BBB)

36004 PROGRESS AND PROBLEMS IN RADIATION PROCESSING APPLICATIONS. Silverman, Joseph (Univ. of Maryland, College Park). Nucl. News., 11: No. 6, 41-4(June 1968).

The status of radiation processing applications is summarized and its advantages and problems discussed. (M.C.G.)

36005 OPEN ALPHA SOURCE WITH A SPECTRUM OF MORE LINES. Kuzmiak, Mikulas; Beran, Milos; Kruzik, Frantisek (Inst. for Nuclear Research, Prague). Jad. Energ., 14: 152-3(Apr. 1968). (In Czech).

An α-source prepared from ^{228}Th is described. The ^{220}Rn source was analyzed and low activity emitter spectra were measured. (tr-auth)

36006 HOW NUCLEAR ENERGY WILL SHAPE HOSPITALS. Lennox, David H. (Argonne National Lab., Ill.). Mod. Hosp., 107: 91-4(Dec. 1966).

Before a replacement heart becomes feasible, the internal power system must become more efficient. One possibility is to use the heat directly from the radioisotope without first converting it to electricity. Theoretically, the over-all efficiency can be increased by more than a factor of 10 by using a direct thermal cycle similar to a miniature steam engine coupled directly to a pump. In addition, miniature radioactive power packs can be a source of ionizing radiation. Some interesting potential uses for such power supplies in the hospital are: in cordless heating pads or thermal suits; as ionizers to eliminate static electricity in areas where combustibles are used, and to supply electrical power for small transducer-radio sets that can monitor various body functions and transmit the information to a central readout room. (BBB)

36007 THE USE OF Pu–α–Be AS A CALIBRATED GAMMA RAY SOURCE. Drake, D. M. (Los Alamos Scientific Lab., N. Mex.); Hopkins, J. C.; Martin, J. T.; Conde, H. Nucl. Instrum. Methods, 62: 349-50(July 1, 1968).

The number of 4.43 MeV gamma rays per neutron produced by Pu–α–Be sources has been measured to be 0.54 ± 0.04. (auth)

36008 PREPARATION OF A CARRIER-FREE ^{113}Sn SOURCE. Sommer, H. (Univ., Heidelberg). Nucl. Instrum. Methods, 62: 345-6(July 1, 1968).

The ^{113}Sn, resulting from a (d,2n)-reaction of ^{113}In, was separated from the indium by means of fractional distillation. The specific activity of the ^{113}Sn source is at least 180 Ci/g In. (auth)

36009 COLLECTOR POCKET FOR AN ISOTOPE-SEPARATION DEVICE. Naito, Takio (to Hitachi Ltd.). Japanese Patent 1967-17916. Oct. 17, 1967. Filed Apr. 1, 1963.

The design of a collector pocket which is easy to construct and lends itself to repeated usage is given. The collector pocket, which is open on one end, consists of the inner lining and the outside walls surrounding the case; cooling pipes are installed on to the top and bottom walls. The inner case is formed by engaging together the upper and lower bent-at-the-sides plates. The middle of the case and the outer walls are curved in cross section, the upper and lower plates are parallel with each other. A long plate, set at the center of the middle part, running axially, presses the upper and lower plates outward, against the outside walls. (NSA of Japan)

Materials Testing

36010 (BNWL-SA-1395) A REVIEW OF SELECTED NONDESTRUCTIVE TESTING ACTIVITIES AT BATTELLE NORTHWEST LABORATORY. Worlton, D. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 13, 1968. Contract AT(45-1)-1830. 29p. (CONF-680513-1). Dep. CFSTI.

From Inter-American Conference on Materials Technology, San Antonio, Tex.

A review of the nondestructive testing facilities and equipment at Battelle-Northwest Laboratory is presented. Acoustic emission, eddy current, and critical angle ultrasonic methods of nondestructive testing are described. (R.C.K.)

36011 AUTORADIOGRAPHIC CONTROL OF THE DISTRIBUTION OF Dy_2O_3 DISPERSED IN A MATRIX OF URANIUM OXIDE. Mestdagh, G.; Flipot, A. J. Energ. Nucl. (Paris), 10: 85-92 (Mar.-Apr. 1968). (In French).

Autoradiography of pellets of an intimate mixture of small quantities of dysprosium sesquioxide in uranium dioxide is shown to be an efficient method for control of the dispersion homogeneity. The irradiation conditions and the autoradiography technics and the effect of certain geometric and physical characteristics of the pellets are discussed. Visual examination of a photographic enlargement of the autoradiograph permits a rapid evaluation of the quality of the mixture while determination of the blackening density furnishes quantitative information of the Dy_2O_3 content. (auth)

Protective Structures

36012 (AD-661632) THE DYNAMIC RESPONSE OF BURIED CONCRETE ARCHES, PROJECT 3.2 OPERATION SNOWBALL. Final Report. Palacios, N.; Kennedy, Thomas E. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Sept. 1967. 149p. (AEWES-TR-1-797). CFSTI.

The purpose of Project 3.2 was to evaluate the effect of a 500-ton, TNT, surface burst on small, buried, reinforced concrete arch structures. These structures were of such size that they could be tested in laboratory nuclear simulation devices. Nine structures were tested. Three 30-inch-diameter structures with a 4-inch-thick section buried in dry sand to a depth equal to one-fourth the diameter of the arch were located at the 100-, 200-, and 300-psi predicted ground-surface air overpressure levels. Based upon conventional design theory these structures which had tied-independent footings were predicted to fail at overpressures above 200 psi and to move vertically 1 inch. Six semicircular, 12-inch-diameter, unreinforced concrete arch structures with solid base slabs were designed for and placed at the 150-psi predicted ground-surface air overpressure level. Three structures were placed in dry dense sand and three in saturated sand. The three 30-inch structures were subjected to actual air overpressures of 105, 160, and 320 psi and were damaged only slightly. The structure at the greatest range appeared to have suffered greater flexural damage than the closer-in structures. The 12-inch structures were damaged appreciably by ejecta. Generally, the structures responded in a similar manner. In all cases the blast side moved vertically downward, causing an overturning effect. It was concluded that the design techniques used are apparently conservative. (auth) (USGRDR)

36013 (AD-665379) COMPARISON OF SIMULATION AND FIELD TESTS OF A BURIED CONCRETE ARCH STRUCTURE. Report No. Miscellaneous Paper-1-963. Kennedy, Thomas E. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Jan. 1968. 31p. CFSTI.

The general objective of the study was to test a rigid structure in as large a field test as possible and to compare the results with those obtained from tests of the same type of structure in a laboratory simulation device. To accomplish the field-test part of the objective, three 30-in.-diameter reinforced concrete arches were buried in dense dry sand with 15 in. of cover over the crown and subjected to the effects of a 500-ton TNT blast (Project 3.2, Operation SNOWBALL) at overpressures of 105, 205, and 320 psi. In the laboratory, three structures were tested in the U. S. Army Engineer Waterways Experiment Station's Large Blast Load Generator, an explosively operated plane-wave loader, at over-

pressures of 92, 190, and 301 psi. It was found that the gross motion experienced in the field compared favorably with that obtained in the laboratory. Thrust and moment in the arch ring correlated; however, moment distribution in the arch ring appeared to be related to the impingement angle of the stress wave. Shock-spectrum comparison indicated that the free-field spectrum in the field and laboratory when compared with spectrum at a point on the structure generally exhibited an empirically predictable ratio. Consequently, the shock-spectrum envelope at certain points on these structures can be constructed for field loadings based on laboratory and free-field data. (auth) (USGRDR)

36014 (AD-666204) SIMILITUDE STUDY OF FLEXIBLE BURIED ARCHES SUBJECTED TO BLAST LOADS. Balsara, Jimmy Piroshaw (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Jan. 1968. 145p. (AEWES-TR-1-807). CFSTI.

Thesis.

The objective of the study was to investigate and verify model-to-prototype scaling relations for blast loaded buried arches that respond both elastically and inelastically. Four geometrically similar, semicircular aluminum alloy arches with 4-, 8-, 12-, and 36-inch diameters were buried in dense dry sand and subjected to air-blast-induced loads on the surface. The tests were conducted at the Large Blast Load Generator located at the U. S. Army Engineer Waterways Experiment Station. The results of two series of tests, each consisting of 3 repeated shots, ranging from 70 to 300 psi, are presented. Within the range of parameters investigated, the scaling of the dependent variables were adequately verified. These variables included acceleration, velocity, displacement, thrust, and bending moment. (auth) (USGRDR)

Radioactive Material Handling

Refer also to abstracts 35920, 35924, and 35973.

36015 (AD-663128) CONCENTRATION OF MIXED FISSION PRODUCTS FROM SEAWATER BY CHELEX 100. Lai, M. G.; Goya, H. A. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 10, 1967. 25p. (USNRDL-TR-67-128). CFSTI.

A study was conducted to determine the feasibility of concentrating mixed fission products in seawater by ion exchange. Chelex 100, a chelating resin, was found to be effective for the concentration of several gamma-emitting fission-product radionuclides from seawater. The effects of fission-product age, total seawater volume, and flow rate on adsorption were studied. (USGRDR)

36016 (RISO-M-735) DET RADIOAKTIVE AFFALD FRA ATOMKRAFTVAERKER. (Radioactive Waste from Atomic Power Stations). Bjerge, T. (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr. 1968. 6p. Dep.

The highly radioactive waste from atomic power stations is at present generally stored in liquid form in stainless steel containers. It seems possible to further concentrate the wastes by solidification in the form of glass. Even with an atomic power production level much in excess of the present total power production level, the storage for a thousand years or more will not constitute a serious space-consuming problem. The questions of krypton-85 and tritium are also touched upon. (auth)

36017 (SZS-5/68) MOEGLICHKEITEN ZUR BESEITIGUNG RADIOAKTIVER ABFAELLE IN SALZFORMATIONEN AUF DEM TERRITORIUM DER DEUTSCHEN DEMOKRATISCHEN REPUBLIK. (Possibility for the Disposal of Radioactive Waste into Salt Formations in the Territory of the DDR). Fulda, D.; Schwandt, A.; Richter, D. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Feb. 1968. 25p. (In German). Dep.

The conditions for the disposal of radioactive wastes into salt formations are favorable in the G.D.R. because of the widespread occurrence of salt formations and to the existing salt mines. The feasibility of the use of salt mines for the storage of radioactive wastes is considered concerning abandoned mines and mines which are still working or will be abandoned in the near future. The most suitable conditions for the disposal of low and medium level radioactive wastes on an industrial scale and for a definite storage of highly active wastes exist in some salt mines which will be abandoned in the next few years. Storage costs would be below 100 Marks/m^3 for amounts of more than 10,000 m^3 per year. The conditions for dissolving special caverns in salt are also promising. (auth)

36018 DECONTAMINATION OF RADIORUTHENIUM FROM RADIOACTIVE WATERS BY SORPTION ON INORGANIC AND ORGANIC SORBENTS. Kepak, Frantisek (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 14: 131-3(Apr. 1968). (In Czech).

Economic aspects of treating radioactive wastes by sorption are discussed. A brief review is given of methods for decontamination of ruthenium isotopes from radioactive waste water by adsorption on inorganic absorbers such as unsoluble metal sulfides and hydrates, hydrated oxides, phosphates, powdered metals, and natural absorbers and on cellulose base or humic acid absorbers, and organic ion changers. (tr-auth)

36019 HIGH LEVEL RADIOACTIVE WASTE BURIAL IN CZECHOSLOVAKIA. Saidl, Jaroslav; Safar, Otakar (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 14: 140-1(Apr. 1968). (In Czech).

The preliminary project of utilizing the abandoned limestone mine "Richard" near Litomĕřice, for the storage of high level radioactive wastes from the reprocessing plants which have been converted into solid and chemically resistant materials, is given. The mine spaces have favorable dimensions and spatial arrangement available for operating and for health safety of the operators. Geologic and hydrogeologic conditions of the burial are very advantageous. The territorial zoning allows a closed non-interfering complex to be built in the environment. Relatively low expenses will be necessary for adapting the storage site as compared with the constructions of a new one. It should be possible and recommendable to place the reprocessing plant in the neighborhood of the burial if precautions are enforced. (auth)

36020 BUILT-UP RADIOACTIVE-MATERIAL TRANSPORT CONTAINER. Sawai, Sadamu (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-19557. Oct. 2, 1967. Filed June 5, 1963.

A radioactive-material transport container, for any size (and shape) and any activity level of a radioactive material, can be readily obtained. From among many similar-shaped (open) containers, two are selected for a given radioactive material. The smaller container is fixed onto the lower side of a round plate, its opening end just fitting to the same-size hole in the plate. This round plate, with the smaller container, is fixed onto the open end of the other larger container, serving as the lid to the latter. Lid closing is done by bolts. A small hole is cut through the lid at an appropriate position. The space between the outer and inner containers is filled with shielding granular material by introducing it through the small hole. After placement of the radioactive material in the inner smaller container, it is closed with a plug. (NSA of Japan)

36021 SPENT FUEL-ROD (HANDLING) CASK. Itsumi, Fumihiko (to Hitachi Ltd.). Japanese Patent 1967-15517. Aug. 26, 1967. Filed Mar. 28, 1963.

An improved cask is proposed, by which a spent fuel-rod, after removal from the reactor, can be transported safely to its storage. The shielded cask is set onto the top of a nuclear reactor. A spent fuel-rod is taken into the cask by winding a rope, and stops automatically at a specific position. A spherical rotary valve is so installed at the entrance to the cask that, interlocked with the winding mechanism, it does not operate until the fuel rod reaches the specific position. A fuel-rod path is made through the middle of this spherical valve; a path for contaminated heavy-water coolant runs through one of the rotary valve support rods and a path for coolant gas through the other support rod. The outlets of these paths automatically connect to the paths through the cask body when the rotary valve has been turned after containment of the fuel rod. (NSA of Japan)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 36122, 36134, 36296, 36297, 36567, 37281, and 37340.

36022 (AE-317) LOW LEVEL RADIOACTIVITY MONITOR FOR AQUEOUS WASTE. Quirk, E. J. M. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Apr. 1968. 35p. Dep.

A system is described for continuous monitoring of very low levels of radioactivity in waste water containing typically 3.5 g/l dissolved solids. Spray evaporation of the water enables the dissolved solids to be recovered in the form of an aerosol and collected on a filter tape where the radioactivity is measured by a radiation detector. The advantage of this method compared with a direct measurement is that the attenuating effect of the water is removed and thus greater sensitivity is obtained. Compensation for background and any contamination is achieved by feeding distilled water to the aerosol generator every alternate sampling period and recording the count difference between two successive sampling periods. A printed record of the total count difference is obtained once per hour during the integration time of one month. For β radioactivity the minimum values of specific activity measurable extend from $1 \cdot 10^{-6}$ Ci/m^3 to $6 \cdot 10^{-9}$ Ci/m^3 depending on the β end-point energy in the range 167 keV to 2.26 MeV. The estimated minimum measurable specific α activity is $6 \cdot 10^{-8}$ Ci/m^3. (auth)

36023 (ANL-Trans-621) POSITION-SENSITIVE COUNTERS. Kuhlmann, W. R.; Lanterjung, K. H.; Schimmer, B.; Sistemich, K. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Nucl. Instrum. Methods, 40: 118-20(1966). 6p. Dep. CFSTI.

Charged particles produce in proportional counters with the cathode or the anode of material with suitable resistance an energy-independent information of the position which is a linear function of the location. The resolution of the counter to be described (length 30 cm) amounts to 1.2 mm. (auth)

36024 (ANL-Trans-622) PULSE DIVISION CIRCUIT. Kuhlmann, W. R.; Schimmer, B. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Nucl. Instrum. Methods, 40: 113-17(1966). 11p. Dep. CFSTI.

For experiments with detectors for localization of particles a pulse division circuit was evaluated that derivated an output pulse from two coincident input signals U_1, U_2, the amplitude of which was proportional to the quotient $Q = U_1/U_2$ of the two input signals. The circuit works in a range $1 \leq Q < 5$. For $Q = 1$ the input signals may vary in a range $8\ V < U_{1,2} < 100\ V$, for $Q = 3$ in $30\ V < U_1 < 100\ V$ and $10\ V < U_2 < 33\ V$. The greatest repetition rate with periodical pulses is about 5 kc/s for $Q = 3$ and $U_2 = 20$ V, if one wants to keep the deviations from the value at low frequencies below 10%. The output signals are so shaped, that they may be analysed directly by the usual multi-channel-pulseheight-analyzators ($t_r < 0.5$ μsec; $t_f < 3$ μsec). The input signals have to accomplish only one condition: their risetime t_r must be less than 0.5 μsec. (auth)

36025 (BNWL-SA-1621(Rev.)) RECENT ADVANCES IN REGENERATIVE IN-CORE NEUTRON FLUX MONITORS. Jackson, Charles N. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 31, 1968. Contract AT(45-1)-1830. 16p. (CONF-680601-21). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Recent investigations in the development of regenerating flux monitors, a novel detector concept that employs a mixture of fertile and fissile uranium isotopes (90% ^{234}U-10% ^{235}U), are reported. In this coating material ^{234}U transmutes by thermal neutron absorption to ^{235}U replacing similar atoms lost due to burnout thereby accomplishing the regenerating function and extending the useful life of the neutron sensor. In-core irradiation tests at the ETR are summarized. (B.G.D.)

36026 (BNWL-SA-1632) TISSUE EQUIVALENT PROPORTIONAL COUNTER FOR SEPARATING DOSES DUE TO GAMMA AND NEUTRON RADIATION. Endres, G. W. R.; Glass, W. A.; Haverfield, A. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 28p. (CONF-680607-6). Dep. CFSTI.

From 13th Annual Health Physics Society Meeting, Denver, Colo.

It is shown that sealed and gas flow tissue-equivalent proportional counters can be made to function satisfactorily for use in monitoring neutrons in mixed neutron-gamma radiation fields. It is made apparent that in addition to providing absorbed dose and QF measurements in radiation work zones, there exists a good possibility of developing the tissue-equivalent proportional counter into a standard for absorbed dose measurements. (B.G.D.)

36027 (CONF-680303-, pp 1-11) STATISTICAL FACTORS IN NUCLEAR RADIATION DETECTORS. Goulding, F. S. (California Univ., Berkeley. Lawrence Radiation Lab.).

Statistical problems involved in deriving the amplifying signals from radiation detectors are discussed. Topics discussed include energy absorption-electrical signal conversion processes in various detectors, electronic noise, microphonics, nuclear collisions, and trapping effects. (W.H.K.)

36028 (CONF-680303-, pp 169-88) SIGNAL-TO-NOISE RATIO ENHANCEMENT IN NUCLEAR INSTRUMENTATION. Ducote, Louis W. (California Univ., Livermore. Lawrence Radiation Lab.).

The process of detecting signal in a noise background has been treated in the past primarily by front-end discrimination techniques. Signal isolation with front-end components can be augmented by systems designed to process an obscure signal in a manner which enhances the signal-to-noise ratio. Identification of signal and noise are described, and optimum impedance circuits are reviewed. The signal is broken down into spectral components, while the random noise is derived from equivalent generators. The use of correlation systems to process signals is described and intrinsic problems are evaluated. The elimination of intermodulation products by use of a coherent system is also described. The application of signal processing is applied to transient signal detectors particularly related to pulse-modulated systems. The systems described are compared on an approximate basis limited by the output signal compatibility. (auth)

36029 (D-1-82-0720) X-RAY TELESCOPE USING ASYMMETRIC BRAGG CRYSTAL-PLANE DIFFRACTION. Lytle, F. W.; Bingham, R. G. (Boeing Scientific Research Labs., Seattle, Wash. Solid State Physics Lab.). May 1968. 11p.

A cone covered on the inner surface with a mosaic of small crystals is used to concentrate parallel x rays onto one small detector. Optimized cones of 20-40 cm diameter with lithium fluoride crystal provide gains of 100 or better from 5-20 keV. The estimated minimum detectable photon flux at 8 keV is 3×10^{-5} photons cm^{-2} sec^{-1} keV^{-1}. (auth)

36030 (DPSPU-67-30-1) REMOTE TRITIUM AIR MONITORING SYSTEM. Morris, E. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Apr. 1967. Contract AT(07-2)-1. 9p. (SM-95-50; CONF-670704-7). Dep. CFSTI.

From IAEA Symposium on Instruments and Techniques for the Assessment of Airborne Radioactivity in Nuclear Operations, Vienna, Austria.

A remote tritium monitoring system, utilizing Kanne ionization chambers and associated electronic equipment, developed for use at the Savannah River Plant is described. (B.G.D.)

36031 (IA-1153) PRODUCTION OF GERMANIUM LITHIUM DRIFTED DETECTORS AT THE SOREQ NUCLEAR RESEARCH CENTER. Sever, Y. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Jan. 1968. 10p. Dep.

The advantages of laboratory-constructed lithium-drifted germanium detectors are discussed and some features of detector production are described. Data on the performance of a laboratory-constructed detector are given. (auth)

36032 (N-68-16913) SOUNDING ROCKET FLIGHT OF A DIRECTIONAL NEUTRON DETECTOR. Final Report, December 29, 1966-September 30, 1967. (American Science and Engineering, Inc., Cambridge, Mass.). Nov. 28, 1967. Contract NASw-1540. 91p. (NASA-CR-92683; ASE-1708). CFSTI.

A directional neutron detector was built, along with appropriate electronics, a sun sensing device, and a nose cone ejection system. The phosphor for the scintillation counter was constructed of small glass tubes filled with scintillation fluid encased in clear epoxy, and completely surrounded by a cosmic ray anti-coincidence shell of CsI. The experimental apparatus was integrated into a Nike-Apache sounding rocket and launched from Wallops Island, Va., on 13 June 1967. Pulse height and pulse shape information telemetered to the ground station for subsequent two parameter analysis determined the type of radiation detected, as well as its energy spectrum. Except for the inadequate rejection of cosmic-

ray particles, the system functioned as planned, demonstrating the suitability of this type of detector for solar neutron measurements. (auth) (STAR)

36033 (N-68-22703) A SOLID STATE DETECTOR EXPERIMENT FOR ELECTRON MEASUREMENTS ON OGO-F. Trainor, James H.; Williams, Donald J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). [1968]. 16p. (NASA-TM-X-63195; X-611-68-119). CFSTI.

A solid-state detector system is described which has been developed for flight on an orbiting geophysical observatory in polar orbit. Measurements will be made of the electron flux and spectra above 35 keV, both for precipitating and locally mirroring electrons, as well as atmospheric backscatter. The physical need and the design requirement of such an experiment are reviewed and the detector and electronic implementation of the experiment including the methods of monitoring detector and electronic performance in flight are described. (auth) (STAR)

36034 (NYO-3540-1) DEVELOPMENT OF METHODS OF INDUSTRIAL CONTROL MEASUREMENTS OF LOW-LEVEL CONTAMINATION OF MATERIALS. Final Report. Weller, Richard I. (Franklin and Marshall Coll., Lancaster, Pa. Dept. of Physics). Oct. 30, 1967. Contract AT(30-1)-3540. 31p. Dep. CFSTI.

Commercially available alpha and beta counters have been investigated to determine which of these is applicable to industrial control monitoring of low-activity lead. The results show that standard low-level commercial equipment is satisfactory. The most simple and economical method uses a scintillation counter with thin plastic phosphors for beta particle detection. (auth)

36035 (SLAC-Trans-85) THEORY OF MONITORS OF SECONDARY ELECTRON EMISSION. Bakhshyan, G. G.; Garibyan, G. M. Translated by Robert Addis for Stanford Linear Accelerator Center, Calif., from Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 415-32(1967). 36p. Dep. CFSTI.

A theoretical analysis is made of the operation of monitors of secondary electron emission in a case in which the primary particle is extremely relativistic. It is shown that in the operation of the monitor an essential role is played by the oxide layer that forms on the surface of the metal emitter. If a strong electric field is created in that layer, the secondary-emission current will be dependent on the energy of the primary particles. A qualitative discussion of the influence of a strong electric field on the process of formation of the latent image in the photoemulsion and on de-excitation of the scintillators is presented. Sixty-three references are included. (auth)

36036 MEASUREMENT OF SHORT-LIVED ACTIVITIES USING CONSTANT PAUSE INTERVALS. Plesch, R. (Siemens AG, Karlsruhe, Ger.). Kerntechnik, 10: 279-88(May 1968). (In German and English).

The half-life and the initial activity of a short-lived radionuclide can be calculated by the method of the mean life, the method of weighted mean and the method of alternating summation. All these methods require appropriate modifications when a scaler with adjustable pause intervals is used. The formulae given are illustrated by numerical examples. (auth)

36037 MANGANESE BATH TECHNIQUE FOR MEASURING THE NEUTRON YIELD OF ACCELERATOR SOURCES. Scott, M. C. (Univ. of Birmingham, Eng.). pp 283-90 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18-19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

The use of the continuous flow manganese bath technique to measure the yield of neutron sources which vary with time in some known manner is described, and the results of tests on the method are given. (auth)

36038 METHOD AND APPARATUS FOR DETERMINING COOLING AGE OF NUCLEAR REACTOR FUEL. (to United States Atomic Energy Commission). British Patent 1,115,757. May 29, 1968. Priority date Dec. 14, 1965, United States.

A scintillation detector system and method for determining the period of time which irradiated fuels have been allowed to age since their removal from a nuclear reactor are presented. The method consists of comparing the gamma count rate of an isotope having a relatively long half-life with the gamma count rate of an isotope having a relatively short half-life. (W.H.K.)

36039 SPACE RADIATION MONITORING SYSTEM FOR SUPPORT OF MANNED SPACE FLIGHT. Ewing, Dean E. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). pp 142-6 of Biomedical Sciences Instrumentation. Volume 4. Advances in Dynamic Bioinstrumentation for Medicine and Research. Allison, R. D. (ed.). New York, Plenum Press, 1968.

From 5th National Biomedical Sciences Instrumentation Symposium, Albuquerque, N. Mex. See CONF-670514.

The problem of developing a radiation monitoring system for measuring space radiation hazards to manned space systems is discussed. Minimum criteria are presented for the design of such a monitoring system, and the use of a system of three tissue-equivalent ion chambers is proposed to satisfy the minimum criteria. (W.H.K.)

36040 OPTIMIZATION OF WORK WITH RADIATION COUNTERS. Danes, Florin (Polytechnic Inst., Bucharest). Chim. Anal. (Paris), 50: 139-44(Mar. 1968). (In French).

A comparison test of the methods used for complex determinations with radiation counters was developed. The test consists of an adequate division of the total time for analysis between the partial measurements. From this, the optimum division of time may be established. The criterion and method for optimization were applied to different practical cases in the laboratory; and optimum, fixed-time, and fixed-count methods are compared for negligible and non-negligible backgrounds. For analysis of samples in solution it is found that for f_1 (frequency of sample) $> 3\ f_0$ (f_0 = frequency of background), fixed-time analysis is preferred with frequency of the standard as great as possible; for $1.89\ f_0 < f_1 < 3f_0$, fixed-time analysis is preferred with frequency of the standard equal to $(3f_1 - f_0)f_0/(3f_0 - f_1)$; for $f_1 < 1.89f_0$, fixed-count analysis is preferred with standard frequency as great as possible. Application to other types of analysis is discussed. (BBB)

36041 WELL CHAMBER WITH ASSOCIATED ELECTROMETRIC CIRCUIT FOR DETERMINING RADIONUCLIDE SOLUTION ACTIVITY. Colangelo, S.; Stampacchia, V.; Terrani, S. (Politecnico, Milan). Energ. Nucl. (Milan), 15: 210-12(Mar. 1968). (In Italian).

A well chamber device for the measurement of the radionuclide activity in liquid samples is described. A schematic diagram of the well chamber is given and the electrometric circuit is presented. The circuit uses as an input stage a field-effect transistor with isolated gate. The operational characteristics of the apparatus are reported and illustrated graphically. (J.S.R.)

36042 END-EFFECT ELIMINATION IN PROPORTIONAL COUNTERS USING FIELD-TUBE PULSES. Heiberg, S. A. (Defence Chemical, Biological, and Radiation Establishment, Ottawa). Nucl. Instrum. Methods, 63: 71-4(July 15, 1968).

Pulses appearing on the field tubes of a proportional counter have been used to identify and cancel anode pulses due to tracks located near the end boundary of the active volume. Spectra from a collimated alpha source and from the $^3He(n,p)^3H$ reaction are presented to demonstrate the effectiveness of the technique in eliminating end effect. (auth)

36043 SCHEME FOR QUENCHING GAS-DISCHARGE COUNTERS WITH VOLTAGE REVERSAL. Barkan, A. Z.; Dolgirev, E. I. Geofiz. App., No. 30, 118-21(1966). (In Russian).

A quenching scheme is described which essentially improves the calibration characteristic of a group of gas-discharge radiation counters connected in parallel. (Geophys. Abstr.)

36044 RELATIVISTIC RISE OF THE MOST PROBABLE ENERGY LOSS IN A GAS PROPORTIONAL COUNTER. Ramana Murthy, P. V. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods, 63: 77-82(July 15, 1968).

The most probable energy loss in a gaseous medium, as also in other media, was theoretically predicted by Landau to increase with p/(mc), the ratio of momentum to the rest mass of a charged particle. The predicted magnitude of this rise (referred to as relativistic rise) was verified up to p/(mc) ≈50 in gases in the previous experiments. A method of distinguishing protons from pions in the cosmic radiation at energies ≳100 GeV based on the relativistic rise of the most probable energy loss was previously discussed. For this method to be successful, it is important to verify experimentally the magnitude of the relativistic rise further up to values of p/(mc) ≈ 2000. An experiment carried out to verify this is described and the results presented. The results seem to show that the experimentally determined relativistic rise of the most probable energy loss is less than what the theory predicts. (auth)

36045 HIGH-SPEED METHODS IN NUCLEAR PHYSICS. Neuert, H. pp 941-79 of Kurzzeitphysik. Vollrath, K.; Thomer, G. (eds.). Wien, Springer-Verlag, 1967. (In German).

A bibliographic review is made of the high-speed methods used in nuclear physics. The excited state of nuclei with short lifetimes, time-of-flight methods for the determination of particle pulse, energy, and mass, and studies on the fast fluorescent decay

in organic and inorganic scintillations with use of radioactive emitters are considered. (J.S.R.)

36046 EDGE PROTECTION IN GERMANIUM DETECTORS. Paris, P. (CNRS, Orsay, France); Treherne, J. Nucl. Instrum. Methods, 63: 123-4(July 15, 1968). (In French).

The compensated region of a Ge(Li) detector has been coated with a thin plastic film. The detector, cooled to 77°K, exhibits good energy resolution. Such a protection decreases the effects of superficial stains. (auth)

36047 MEASUREMENT OF PULSE SHAPE DISCRIMINATION PARAMETERS FOR SEVERAL SCINTILLATORS. Miller, T. G. (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instrum. Methods, 63: 121-2(July 15, 1968).

Pulse shape discrimination parameters for several scintillators were measured using zero crossover techniques. The separation and resolution for particle identification was measured for stilbene, Ne 213 and anthracene. (auth)

36048 MEASUREMENT OF SCINTILLATION DECAY TIMES BY MEANS OF SIMULATED PHOTOMULTIPLIER PULSES. Mathe, Gy. (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Instrum. Methods, 63: 117-20(July 15, 1968).

Pulses of scintillation detectors could be simulated through illuminating a photomultiplier cathode by a constant light and controlling its grid by exponential pulses. The pulses produced this way could be used for measuring the decay times of NaI(Tl) and CsI(Tl) crystals, by the use of a pulse shape discriminator. (auth)

36049 MEASUREMENT OF ^{14}C AND TRITIUM IN THE EFFLUENT OF A GAS CHROMATOGRAPHY COLUMN. Karmen, Arthur (Johns Hopkins Medical Insts., Baltimore). J. Amer. Oil Chem. Soc., 44: 18-25(Jan. 1967).

Methods of measuring radioactivity in the effluent of a gas-liquid chromatography (GLC) column are reviewed. The effluent of a GLC column can be assayed for radioactivity during the course of an analysis, if there is sufficient radioactivity in individual compounds to be measurable with acceptable precision in less than 15 to 20 sec. The effluent can be passed directly through a heated ionization chamber or proportional counter; both of these are somewhat sensitive to composition change in the gas. The effluent can also be combusted to carbon dioxide and water, and the water then converted to HT for tritium assay. These gases can then be assayed in an ionization chamber, proportional counter, or flow-through scintillation counter. The detector volume and gas flow rate can then be large, so that changes in gas composition occurring in the course of an analysis are minimized. The gas flow is adjusted for optimal response speed. Combustion trains have been developed that minimize memory effects in tritium assays. Convenient calibration methods are available for setting up the methods and for determining their efficiencies. With insufficient radioactivity in the sample for measurement in a short time interval, the effluent can be fractionated; high boiling material in each fraction can be condensed out and assayed for radioactivity over longer periods. Automatic and quantitative fraction collecting devices have been developed for use with liquid scintillation counters; this method of radioassay has become accurate as well as highly sensitive. (BBB)

36050 RADIOIZOTOPNYYE PRIBORY V METALLURGII. (Radioisotope Instruments in Metallurgy). Afanas'ev, Vadim Nikolaevich; Latyshev, Vladislav Konstantinovich; Lyndin, Vasiliy Vasil'evich; Felinger, Aleksandr Konstantinovich Moscow, Izdatel'stvo Metallurgiya, 1966. 224p.

A book intended for engineering personnel specializing in controlling various parameters of technological processes by using nuclear radiation and radioisotope measuring instruments, especially those instruments which are used in the field of metallurgy is presented. Data useful for development of new instruments which may facilitate dealing with problems of metallurgical industry are given. The titles of the chapters are: nuclear radiation and its interaction with the substance, basic elements of radioisotope instruments, basic characteristics of radioisotope instruments, structural systems of radioisotope instruments, measuring the level of aggressive and loose media in metallurgical units, measuring of thickness of rolled sheets, measuring of pressure and consumption of liquids and gases in metallurgical units, and problems of radiation safety in using radioisotope instruments in metallurgy. (ATD)

36051 NEUTRON DETECTOR FOR OPERATION IN HIGH GAMMA FLUXES. Meal, Thomas J.; Stokes, Arthur J. (to Reuter-Stokes Electronic Components, Inc.). U. S. Patent 3,381,131. Apr. 30, 1968. Filed May 4, 1965.

A neutron detector which is substantially immune to gamma rays and capable of repetitive operation in high gamma-ray environments is described. Design and performance of a boron trifluoride ionization chamber in which the inner walls are coated with a getter material which acts to absorb impurities in the filler gas produced by dissociation due to background gamma radiation are presented. (W.H.K.)

36052 PORTABLE DEVICE FOR CALIBRATING GAMMA-RADIOMETERS. Artsybashev, V. A.; Popov, E. P. Geofiz, App., No. 30, 122-5(1966). (In Russian).

Existing methods of calibrating gamma radiometers have a number of defects. A method and the appropriate device are described which are free of those defects and permit calibration of gamma-radiometers in a limited space. The device is safeguarded against radiation leakage and easily transportable. (Geophys. Abstr.)

36053 FAST NEUTRON SCINTILLATION DETECTOR WITH GAMMA RADIATION DISCRIMINATION. Nikodemova, Denisa; Uhrik, Frantisek (Research Inst. of Work Hygiene and Professional Diseases, Bratislava). Jad. Energ., 14: 145-8(Apr. 1968). (In Czech).

A scintillation detector of fast neutrons with organic scintillator is described. Pulse shape discrimination is utilized for the separation of neutrons from gamma radiation. Two methods of discrimination have been investigated, with photomultiplier working in linear and unlinear régimes. The maximum separable gamma background has been determined. (auth)

36054 OPEN POINT COUNTER FOR VERY SOFT SOURCES β. Spurny, Zdenek (Inst. of Nuclear Research, Prague); Hava, Ludvik; Novotny, Josef Jad. Energ., 14: 137-9(Apr. 1968). (In Czech).

The construction and properties of an open point counter bridged over only with an accelerating grid, having ethyl alcohol vapor as quenching atmosphere at 40°C and at atmospheric pressure, and having a platinum point is described. The counter is designed as an exoemission detector, but it may be used for activity determinations of very soft alpha and beta emitters as well. (auth)

36055 A ^6Li SANDWICH SEMICONDUCTOR DETECTOR FOR FAST NEUTRON SPECTRUM MEASUREMENT. Bishop, G. B. (Univ. of Liverpool). Nucl. Instrum. Methods, 62: 247-52(July 1, 1968).

A ^6Li sandwich semiconductor detector has been developed to measure fast neutron spectra in the core of the University's Research Reactor. The aim of the design has been versatility in use. The same semiconductor junctions can be used for both background and spectra measurements. The thickness of ^6LiF between the junctions can be varied and boron layers can be added if required. The method adopted for junction fabrication requires minimum silicon handling and eliminates the problem of connecting the electrical leads to the silicon electrodes. Preliminary results obtained with the sandwich detector are presented. (auth)

36056 HIGH VOLTAGE SUPPLY FOR SOLID STATE PARTICLE DETECTORS. Withnell, R. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 62: 351-2(July 1, 1968).

A high voltage supply has been developed for the biasing of solid state detectors. The unit is normally line powered, but in event of power failure an internal supply will cause the instrument to function without interruption for up to 7 hr. (auth)

36057 A TIME COMPENSATION METHOD FOR COINCIDENCES USING LARGE COAXIAL Ge(Li) DETECTORS. Fouan, J. P.; Passerieux, J. P. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 62: 327-9(July 1, 1968).

A method is described to compensate for the time jitter due to slow and variable pulse rise times. This allows work with any type of detector and gives a time resolution $2\tau < 10$ ns, for all gamma energies down to 100 keV. (auth)

36058 THE RESPONSE OF DOUBLE-SCINTILLATOR FISSION-FRAGMENT DETECTORS TO ^{252}Cr. Wehring, B. W.; Rohan, P. E.; Shapiro, N. L.; Wyman, M. E. (Univ. of Illinois, Urbana). Nucl. Instrum. Methods, 62: 330-2(July 1, 1968).

Two different scintillation detectors for the coincidence detection of fission fragments are described. The response of the detectors to ^{252}Cf is given. (auth)

36059 USE OF MULTIWIRE PROPORTIONAL COUNTERS TO SELECT AND LOCALIZE CHARGED PARTICLES. Charpak, G.; Bouclier, R.; Bressani, T.; Favier, J.; Zupancic, C. (CERN, Geneva). Nucl. Instrum. Methods, 62: 262-8(July 1, 1968).

Properties of chambers made of planes of independent wires placed between two plane electrodes have been investigated. A direct voltage is applied to the wires. It has been checked that each wire works as an independent proportional counter down to separations of 0.1 cm between wires. Counting rates of 10^5/wire are easily reached; time resolutions of the order of 100 nsec have

been obtained in some gases; it is possible to measure the position of the tracks between the wires using the time delay of the pulses; energy resolution comparable to the one obtained with the best cylindrical chambers is observed; the chambers operate in strong magnetic fields. (auth)

36060 TIMING OF SEMICONDUCTOR DETECTORS WITH A CONSTANT-FRACTION DISCRIMINATOR. McKee, B. T. A. (Dalhousie Univ., Halifax, Can.). Nucl. Instrum. Methods, 62: 333-6(July 1, 1968).

A simple constant-fraction discriminator times pulses from a planar Ge(Li) detector. Time resolution is close to that with leading-edge discrimination, and there is negligible time walk. (auth)

36061 DETERMINATION OF THE p/β RATIO FOR PLASTIC SCINTILLATORS WITH DIFFERENT BASES AND ADDITIONS. Tsirlin, Yu. A.; Zalyubovskii, I. I.; Sokolovskaya, T. I.; Vypirailenko, V. D.; Sarana, V. D. (VNII of Monocrystals, Kharkov). Prib. Tekh. Eksp., No. 1, 55-7(Jan.-Feb. 1968). (In Russian).

The p/β ratio of some plastic scintillators with different bases and additions was measured. It was shown that during irradiation with protons at E = 1.3 MeV and electrons with E = 0.624 MeV the plastic scintillators with base of polystyrene, poly(vinyltoluene) and poly(vinylxylene) with additions of 2% PPP and 0.1% POPOP, the p/β ratio is the same and equals 0.2; plastic scintillators with poly(methyl methacrylate) base have a p/β ratio of 0.042. The p/β ratio of some is reduced with increase of the concentration of the first addition and increased with increase of the proton energy. (tr-auth)

36062 EVALUATION OF THE UPPER ENERGY OF ELECTRONS DURING COMPTON SCATTERING. Kish, G. M. (Central Inst. of Physical Studies, Budapest). Prib. Tekh. Eksp., No. 1, 20-2(Jan.-Feb. 1968). (In Russian).

A method for the evaluation of the upper limit of the energy of electrons during Compton scattering with monoenergetic γ quanta was proposed. The method took into consideration the experimental dependence of the scattering capacity of the pulse amplitude spectra on the energy, obtained in the photomultiplier output from the monoenergetic electron beam absorbed in the scintillator. (tr-auth)

36063 DELAY TIME OF PULSES IN CO_2 COUNTERS. Karasik, A. S. (Permsk State Univ., USSR). Prib. Tekh. Eksp., No. 1, 76-7(Jan.-Feb. 1968). (In Russian).

By the triple delayed coincidence method, it was shown that the delay time of pulses, caused by the passage of ionized particles through Geiger counters, filled with carbon dioxide with quenching additions of cyclohexane, does not exceed ~0.25 μsec. (tr-auth)

36064 PREPARATION OF POLYCRYSTALLINE SCINTILLATION LAYERS. Shalaev, B. I. (Union NII of Instrument Construction, Moscow). Prib. Tekh. Eksp., No. 1, 59-60(Jan.-Feb. 1968). (In Russian).

The construction of installations and technological processes guaranteeing the deposition of stilbene on light-conducting backings of different forms and dimensions from plastic, photoglass, scintillation plastics with surface densities up to 100 mg/cm^2, and anthracene on light-conducting supports of photoglass, and deposition of organic scintillators directly on the face of sections of the photomultiplier were described. (tr-auth)

36065 FUNCTIONAL CONVERTER OF THE CURRENT OF IONIZATION CHAMBERS INTO PULSE SIGNALS. Myazdrikov, O. A. (Inst. of Aviation Instrumentation, Leningrad). Prib. Tekh. Eksp., No. 1, 65-8(Jan.-Feb. 1968). (In Russian).

The functional converter of the direct current of ionization chambers into pulse signals using vacuum self-oscillating systems in the macrocharges was examined. The pulse frequency is proportional to the square root of the output of the dose. The converter increases the signal/noise ratio, simplifies the electronic circuit, and guarantees the measurement precision of at least ±5% at dose outputs up to 100 roentgen sec^{-1}. (tr-auth)

36066 HIGHLY EFFECTIVE DETECTOR OF THE POLARIZATION OF X RADIATION. Sanin, A. A.; Zharko, A. V.; Nikolaev, A. G.; Melioranskii, A. C. Prib. Tekh. Eksp., No. 1, 62-5 (Jan.-Feb. 1968). (In Russian).

A detector of the polarization of soft x rays, characterized by the high efficiency and therefore useful for the measurement in a weak current, was described. A description is given of the experimental installation and the data obtained. (tr-auth)

36067 ELECTRON-OPTICAL METHOD FOR THE MEASUREMENT OF THE PULSE CURRENT OF IONIZING RADIATION. Akopdzhanov, G. A.; Ivanov, G. A. Prib. Tekh. Eksp., No. 1, 78-9(Jan.-Feb. 1968). (In Russian).

The possibility of the measurement of the pulse current of ionizing radiation by means of electron-optical converters was examined. A method and a series of installations for the calibration during the absolute measurement of the current were proposed. The precision of the method and the number of measurement channels realized in one device were evaluated. (tr-auth)

36068 SINGLE CALIBRATION OF PLASTIC SCINTILLATORS. Tsirlin, Yu. A.; Sokolovskaya, T. I.; Daich, A. R.; Shabel'nik, V. P. (VNII of Monocrystals, Kharkov). Prib. Tekh. Eksp., No. 1, 57-8(Jan.-Feb. 1968). (In Russian).

A method for the comparison of plastic scintillators in the form of polished cylinders and rectangular parallelepipeds with a single calibration of the plastic scintillators was proposed. The method is based on the fact that the light yield V of plastic scintillators of the shapes examined in the absence of optical constants of the samples with photocathodes depends only on the height of the detector h. The typical dependence V (h) was deduced. (tr-auth)

36069 REGISTRATION WITH MICA OF FISSION FRAGMENTS DURING INTENSE IRRADIATION OF DETECTORS WITH CHARGED PARTICLES. Rumyantsev, O. V.; Selitskii, Yu. A.; Funshtein, V. B. Prib. Tekh. Eksp., No. 1, 51-2(Jan.-Feb. 1968). (In Russian).

A method for the processing of common mica for the preparation of backgroundless detectors for fission fragments was described. In the case of the tight deposition on the layer of fissioning material, the efficiency of registration is 96 ± 1%. During the registration of the fission fragments of radium, having high α activity, the destruction of the surface of the detectors was observed. For restoration of the crystal structure of the mica, irradiated with fragments and α particles, short-time fritting was used. The effect of the restoration of the detector without change of the sensitivity to fragments was verified by irradiation with α particle currents up to 10^{13}/cm^2 and neutron densities up to 10^{16}/cm^2. (tr-auth)

36070 MEASUREMENT OF THE NUMBER OF FISSION FRAGMENTS BY MEANS OF SILICATE GLASS. Gorshkov, V. K.; L'vov, L. N. Prib. Tekh. Eksp., No. 1, 48-50(Jan.-Feb. 1968). (In Russian).

A method for the increase of the precision of the counting of tracks from fission fragments in glass was described. A curve of the efficiency of the counting of fragments by means of silicate glass was constructed as a function of the distance between source and glass. (tr-auth)

36071 USE OF MICA, QUARTZ GLASS, AND LAVSAN FOR THE RECORDING OF NUCLEAR FISSION. Kapustsik, A.; Perelygin, V. P.; Tret'yakova, S. P.; Sviderskii, V. I. (Joint Inst. of Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 1, 43-7(Jan.-Feb. 1968). (In Russian).

A method for carrying out experiments, recording the fission fragments by means of mica, quartz glass, and lavsan (dacron), was developed. Data on the conditions for the preparation and monitoring, the uranium concentration, the efficiency of the registration of fission events, and the known background were reported for these detectors. The possibility was indicated of using muscovite mica and quartz glass for the registration of rare fission events at temperatures up to 300°C in an atmosphere of gaseous chlorides. (tr-auth)

36072 HIGH VOLTAGE DIVIDER AND LEAKAGE MONITOR. Steinman, A. (Univ. of California, Livermore). Nucl. Instrum. Methods, 62: 323-6(July 1, 1968). (UCRL-70398(Rev.1)).

The design of an instrument which monitors the voltage and current supplied to semiconductor radiation detectors is described. The instrument is designed to remove the voltage if a preset value of detector current is exceeded. In this way any changes in the detector environment, which result in an increase in the leakage current, are prevented from damaging the detector. (auth)

36073 SELF-POWERED NEUTRON DETECTORS. Accinni, F.; Tonolini, F. (Laboratori CISE, Milan). Energ. Nucl. (Milan), 15: 311-21(May 1968). (In Italian).

The self-powered β emitters neutron detectors are described. As their use in high neutron flux monitoring in reactors or in experimental loops becomes more and more extensive, it seemed useful to describe their applications and to make an analysis of their performance. (auth)

36074 A 4π PLASTIC SCINTILLATION DETECTOR. Forbes, G. B. (Univ. of Rochester, N. Y.). Int. J. Appl. Radiat. Isotop., 19: 535-9(June 1968).

Most instruments of this type are not suitable for infants because of their high background rates. The construction and operating characteristics of a small 4π detector designed to mea-

sure ^{40}K and ^{137}Cs in human infants are described. Although the instrument failed to meet in full measure the stated objective, it is capable of detecting very small amounts of gamma activity. (auth) (UK)

36075 WATER-VAPOUR COUNTER FOR THE MEASUREMENT OF TRITIATED WATER. Takahashi, Tan (Inst. of Physical and Chemical Research, Tokyo); Hamada, Tatsuji; Takahashi, Yasuko. Int. J. Appl. Radiat. Isotop., 19: 511-15(June 1968).

A counter filled with tritiated water vapor and heated at about 120°C, was operated successfully by using an electronic circuit which was desensitized for a period of several hundred μs following an input pulse from the counter (interruption time). A high input sensitivity of less than 1 mV, and a sufficiently long interruption time, were found to be essential for obtaining good counting characteristics. (auth) (UK)

36076 AUTOMATIC SAMPLE CHANGER FOR PHILIPS LOW ACTIVITY BETA-COUNTING ASSEMBLY. de Ruig, W. G. (Government Dairy Station, Leiden). Int. J. Appl. Radiat. Isotop., 19: 545-7(June 1968).

In order to enhance the capacity of this assembly, used for fallout measurements in milk and dairy products, an automatic sample changer was needed. A rotating disk model, having 16 positions, is described. (UK)

Nuclear Spectroscopic Instrumentation

36077 (AERE-R-5647) NEUTRON MONOCHROMATOR STUDIES AT AERE. Turberfield, K. C. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1968. 33p. Dep. CFSTI. UK 5s. 6d.

The work described was undertaken to observe and improve the characteristics of certain single crystals for use as Bragg reflecting neutron monochromators. Crystals normally available have micromosaic widths that are inadequate to take full advantage of the intensities available using normally accepted resolution widths. Mosaic widths of up to 30′ to 40′ have been achieved in copper crystals by doping with beryllium and up to 12′ in germanium by distortion at high temperatures. Observation of integrated reflectivities R_θ and mosaic widths η (f.w.h.ht.) of these and other monochromator crystals at wavelengths from 1 to 2Å showed that the peak reflectivities (approx. R_θ/η) are largely independent of η and of the crystal material used, within a factor of about two. (auth) (UK)

36078 (CONF-680303–, pp 205-12) TECHNIQUES FOR REDUCING ELECTRICAL NOISE PICKUP IN BIOMEDICAL COUNTING INSTRUMENTATION. Phelps, Paul L.; Newbold, Frank A.; Sawyer, Douglas L. (California Univ., Livermore. Lawrence Radiation Lab.).

An x-ray spectrochemical system used for the elemental analysis of biological tissues was found to be producing data that deviated from the expected statistical limitations. The associated electronic detection system consisted of a photomultiplier, preamplifier, linear amplifier and single channel discriminator. Several sources of electrical interference were discovered near the system and at remote points and shown to be the cause of erratic data. Electrical radiation from oscillating fluorescence lamps was judged to be the chief source of noise. Also other electrical disturbances were found to be conducted to the system via power lines and the electrical ground. The preamplifier was repackaged, suitable filters incorporated into the supply voltage leads, all cables were shielded and properly grounded, and a new electrical ground was established. The system is judged now to be immune from the sources of noise encountered and has performed satisfactorily for more than 24 months. (auth)

36079 (EUR-3923) UN ANALIZZATORE PER EFFETTO MOESSBAUER AD ALTO POTERE RISOLUTIVO. (A High-Resolution Moessbauer Effect Analyzer). Garroni, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Mar. 6, 1968. 27p. (In Italian). Dep.

The designing aspects and operating characteristics of an advanced equipment for Mössbauer effect analysis are described. This equipment, which was made at the J.R.C.- Euratom of Ispra by the "Control and Automation Section," is characterized by high velocity resolution (25 μ m/sec) and automatic operation. The achieved performances are typically represented by a velocity error of some units in 10^{-4} which emphasizes this equipment among similar ones. (auth)

36080 STATISTICAL NOISE AND SPECTRAL ANALYSIS. Blackburn, J. A. (Univ. of Waterloo, Ont.). Nucl. Instrum. Methods, 63: 66-70(July 15, 1968).

Recent studies in spectral analysis, especially as applied to gamma ray spectroscopy, have indicated that two major sources of error exist. The first, drifting of the zero channel intercept and gain of the multichannel analyzer, has been studied in some detail. The second, statistical fluctuations in the spectra, is the subject discussed. It is shown that errors due to statistical noise depend on the amplitudes of the characteristic peaks in the spectra. Numerical low pass filters are examined to see if any improvement can be effected. (auth)

36081 MECHANICAL CORRELATION CHOPPER FOR THERMAL NEUTRON SPECTROSCOPY. Skoeld, K. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 63: 114-16(July 15, 1968).

An experimental test of a mechanical correlation chopper is described. It is concluded that the correlation chopper is superior to conventional choppers in cases for which the signal to background ratio is low. The diffraction pattern for Cd obtained by the present chopper clearly demonstrates the power of the correlation method in such cases. (auth)

36082 PROTON TRACK MEASUREMENT IN NUCLEAR EMULSIONS BY PHOTOGRAPHIC SCANNING. Bishop, G. B.; Saha, J. K. (Univ. of Liverpool). Nucl. Instrum. Methods, 63: 88-92 (July 15, 1968).

Nuclear emulsions have been irradiated with fast neutrons within the core of the Universities Research Reactor. The resulting proton tracks have been measured using a photographic technique. The proton spectrum so determined has been compared directly with the spectrum obtained by visual scanning with a microscope. Variations in the resulting neutron spectrum are presented and compared with the spectrum calculated using the program G.M.S.I. Providing there are upwards of 15 proton tracks per field of view, the photographic scanning technique offers a saving in scanning time, a permanent record of the proton tracks, simple means of measuring curved tracks and a resulting neutron spectrum comparable with that obtained by other methods. (auth)

36083 OPTIMUM PARAMETERS FOR A CONSTANT DEVIATION MAGNETIC SPECTROGRAPH. Viswesvariah, M. N.; Sarma, N. (Bhabha Atomic Research Centre, Trombay, India). Nucl. Instrum. Methods, 63: 53-6(July 15, 1968).

Certain aspects of the ion optics of a constant deviation magnetic spectrograph are presented and new criteria applied to optimize source distance, incident- and exit angles. Data are presented in tabular form. (auth)

36084 MAGNETIC ANALYZER FOR THE DETECTION OF ^3He RECOIL PARTICLES FROM THE D(d,n)^3He REACTION. Bartle, C. M.; Chapman, N. G.; Johnson, P. B.; Callaghan, J. E. (Victoria University of Wellington, N. Z.). Nucl. Instrum. Methods, 63: 39-44(July 15, 1968).

The design of a double focusing magnetic analyzer to separate low energy ^3He recoil particles produced by the D(d,n)^3He reaction from scattered deuterons and the products of the D(d,p)T reaction is discussed. The improved resolution over previous methods enables the neutron flux from the d-D reaction produced in a thick target to be measured accurately and reliably over an extended range of deuteron energies with good timing resolution in neutron time of flight experiments. (auth)

36085 ONE-CRYSTAL NaI SPECTROMETER. Suffert, M.; Feldman, W.; Mahieux, J.; Hanna, S. S. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 63: 1-12(July 15, 1968).

A total absorption gamma-ray spectrometer has been developed using one large NaI(Tl) crystal (24 cm × 24 cm) surrounded by a plastic scintillator operated in anticoincidence. An energy resolution of 3.6% with a detection efficiency of 24% is achieved for 22 MeV gamma rays. The use of fast electronics for both scintillators makes efficient pileup suppression possible with negligible dead time even in the presence of high background. The effects produced by changing the collimation of the gamma rays and the detection level of the anticoincidence pulses are investigated. (auth)

36086 CERTAIN ASPECTS OF THE CALIBRATION AND RESOLUTION OF SLOW NEUTRON SPECTROMETERS. Amaral, L. Q.; Vinhas, L. A.; Rodriguez, C.; Herdade, S. B. (Cidade Univ., Sao Paulo, Brazil). Nucl. Instrum. Methods, 63: 13-22(July 15, 1968).

The method of calibrating and determining the resolution of slow neutron spectrometers by the measurement of Bragg breaks is discussed. The folding of a Gaussian resolution function with a linear function presenting a sharp break is analytically studied. The ratio between the resulting break width and the resolution width is determined; in practical cases it is 1.0645. A relation between the mean abscissa, corresponding to the half-height of the resulting curve, and the true position of the break is given; they coincide only for symmetrical breaks. The effect of a Gaussian

resolution in the transmission, inverse transmission, and total cross section, is theoretically evaluated for the iron (110) Bragg cutoff, for many resolution widths and several sample thicknesses. It is concluded that the analysis of the measured transmission curve gives the most direct and accurate result. The characteristics of a curved-slit slow neutron chopper and time-of-flight spectrometer built at the IEA are presented. The time resolution for the present conditions of geometry, with a very small detecting area is 1% for a 3 m flight path and 4.046 Å neutrons. A calibration independent of the chopper speed, desirable when a wide energy range must be covered, has been attained within the precision of 4 μsec. The spectrometer can be used from 0.5 up to 12 Å for total cross section measurements. (auth)

36087 UNFOLDING TIME-DEPENDENT GAMMA-RAY PULSE HEIGHT SPECTRA BY VECTOR ANALYSIS. Sharma, R. C. (Bhabha Atomic Research Centre, Trombay, India). Nucl. Instrum. Methods, 63: 75-6(July 15, 1968).

A vector analysis approach is suggested to unfold time-dependent gamma-ray pulse height spectra. (auth)

36088 IMPROVEMENT OF ANGULAR RESOLUTION IN MAGNETIC SPECTROGRAPHS. Kenefick, R. A. (Texas A and M Univ., College Station). Nucl. Instrum. Methods, 62: 347-8 (July 1, 1968). (ORO-3398-11).

Existing instrumentation will give a >10 improvement in angular resolution without diminishing count rate. The effect is broadly analogous to use of a multi-gap instrument of restricted range. (auth)

36089 SPECTROMETRIC SCINTILLATION COUNTER. Koshtoev, V. V.; Karapetyan, V. A. Prib. Tekh. Eksp., No. 1, 60-2(Jan.-Feb. 1968). (In Russian).

A spectrometric scintillation counter of cylindrical shape (ϕ 100 × 10 mm^2) with active surface of 5025 mm^2 (ϕ 80 mm) was described. It has an optical heterogeneity $\omega = 7 \pm 0.5\%$. The counter was developed for a coordinateless mass and energy spectrometer for cosmic radiation. (tr-auth)

36090 SEMICONDUCTOR COUNTER FOR THE SPECTROMETRY OF FAST NEUTRONS. Degtyarev, Yu. G. Prib. Tekh. Eksp., No. 1, 23-9(Jan.-Feb. 1968). (In Russian).

Detectors for the spectrometry of fast neutrons using the reactions $^6Li(n,\alpha)^3He$ and $^3He(n,p)^3H$ were developed. The complete energy of the reaction products was measured by a pair of Si counters, working in coincidence. Their characteristics were examined in detail. The best results on the efficiency of neutron registration and energy resolution were obtained with detectors using ^3He as converter. The detectors can be used for study of the spectra of neutron sources, inelastic scattering of neutrons, and in spectral measurements in reactors. (tr-auth)

36091 LOW-BACKGROUND SCINTILLATION BETA SPECTROMETER. Vakulovskii, S. M.; Silant'ev, A. N. (Inst. of Applied Geophysics, Obninsk, USSR). Prib. Tekh. Eksp., No. 1, 30-3(Jan.-Feb. 1968). (In Russian).

A low-background scintillation β spectrometer for measurement of preparations containing isotopes emitting hard β radiation was described. The background of the installation is 8 imp/hr in the range from 0.5 to 2.5 MeV, and the registration efficiency for ^{90}Y is 21%. (tr-auth)

36092 AUTOMATIC X-RAY SPECTROMETER URS-31 FOR INVESTIGATION OF FINE STRUCTURE OF SPECTRA. Vainshtein, E. E.; Sadovskii, A. P.; Gerasimov, V. M.; Fenogenov, V. M. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Prib. Tekh. Eksp., No. 1, 197-9(Jan.-Feb. 1968). (In Russian).

On the basis of previously constructed and described spectrometer URS-1I, the device URS-3I was developed with completely automatic registration of spectra. The block diagram of the automatic control and the block diagram of the sample holder, permitting placement of the absorber outside the vacuum area during work in the spectral range from 1 to 6 Å, are illustrated. The spectrometer makes it possible to investigate materials in the solid, liquid, and gaseous state. The spectra taken with the automatic device were compared with spectra recorded manually. (tr-auth)

36093 AUTOMATIC INSTALLATION FOR GUARANTEEING THE STABILITY OF BETA-SPECTROMETER MAGNETS. Babenkov, M. I.; Basin, L. A.; Kartashov, V. M.; Troitskaya, A. G. (Inst. of Nuclear Physics, Alma-Ata, USSR). Prib. Tekh. Eksp., No. 1, 33-5(Jan.-Feb. 1968). (In Russian).

Two automatic installations, used for training in the operation of the magnets of β spectrometers, were described. The first installation is used for spectrometers whose magnets are excited by currents above 1 to 1.5 A and the second for magnets whose excitation current does not exceed 1.2 A. The application of the device for the demagnetization of magnets of ketron and $\pi\sqrt{2}$ spectrometers with ρ_0 = 240 mm and ρ_0 = 500 mm showed that as a result of the demagnetization the difference of the topography of the realized field from the theoretical field is greatly reduced (by 2 to 3 times). The residual field does not exceed 0.1 Oe. (tr-auth)

36094 USE OF GAMMA SPECTROMETERS WITH PROTECTIVE LIQUID SCINTILLATORS FOR ANALYSIS OF MIXTURES OF LOW-ACTIVITY FISSION PRODUCTS. Konstantinov, I. E.; Fedorov, G. A. (Inst. of Physics and Engineering, Moscow). Prib. Tekh. Eksp., No. 1, 36-9(Jan.-Feb. 1968). (In Russian).

The parameters of a scintillation γ spectrometer with protective liquid scintillators designed for measurement of fission products with activities from 5×10^{-11} to 10^{-8} Ci were given. This spectrometer, which makes measurements in the coincidence and anticoincidence regime, had advantages over the monocrystal spectrometers. (tr-auth)

36095 SCHEME FOR THE STABILIZATION OF THE AMPLIFICATION COEFFICIENT OF PHOTOMULTIPLIERS OF MULTICRYSTAL SCINTILLATION GAMMA SPECTROMETERS. Lukanin, V. S.; Fedorov, G. A.; Konstantinov, I. E. (Inst. of Physics and Engineering, Moscow). Prib. Tekh. Eksp., No. 1, 40-3(Jan.-Feb. 1968). (In Russian).

The electronic circuits and the results of the mathematical analysis of the operation of the stabilization system of an eight-crystal scintillation γ spectrometer were reported. The results of the experimental testing of the operation of the stabilization system and the spectrometer characteristics were given. The stability attained for the spectrometer was better than 1%, and the resolution was 10.5% for ^{137}Cs photopeaks. (tr-auth)

36096 METHOD FOR THE RAPID CALIBRATION OF GERMANIUM SPECTROMETERS. Walford, G.; Doust, C. E. (Univ. of Surrey, London). Nucl. Instrum. Methods, 62: 353-4(July 1, 1968).

A technique is described for the energy and total peak efficiency calibration of germanium spectrometers using radium in equilibrium with its decay products. (auth)

36097 METHOD FOR THE ANALYSIS OF PULSE-HEIGHT SPECTRA CONTAINING GAIN-SHIFT AND ZERO-DRIFT COMPENSATION. Trombka, J. I. (Goddard Space Flight Center, Greenbelt, Md.); Schmadebeck, R. L. Nucl. Instrum. Methods, 62: 253-61(July 1, 1968).

A method for analyzing pulse-height spectra to determine actual incident differential energy spectra is described. Procedures are given for preparing a library of standard spectra and means of compensation for gain-shift, zero-drift, and background. The procedures and results are given for solving an experimental problem in activation analysis. (auth)

36098 NEW METHOD FOR VELOCITY CALIBRATION OF MOESSBAUER SPECTROMETERS. Fritz, R.; Schulze, D. (Univ., Muenster, Ger.). Nucl. Instrum. Methods, 62: 317-20 (July 1, 1968). (In German).

A device is described for measuring the relative velocity of a Moessbauer source and absorber. It consists of a Michelson interferometer and an electronic recorder and measures instantaneous velocities; the time dependence of the velocities is arbitrary. Resonance velocities for ^{57}Fe measured with this device are reported and compared with the results of other authors. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 37091, 37092, and 37237.

36099 (SLAC-84) THE FORMAL DESCRIPTION AND PARSING OF PICTURES. Shaw, Alan C. (Stanford Linear Accelerator Center, Calif.). Mar. 1968. Contract AT(04-3)-515. 216p. Dep. CFSTI.

Development of a picture description language for analysis and generation of pictures by computer is presented. Topics discussed include a linguistic model for picture processing, the PDL picture description language, the formal description of several picture classes, picture parsing, primitive recognition, and spark chamber film analysis by the SPDL (simple picture description language) system. (W.H.K.)

36100 MEASUREMENT OF THE $\bar{p}$ BEAM PURITY FOR THE 7 GeV/c $\bar{p}$ BUBBLE CHAMBER FILM BY USING δ-RAY SPECTRUM. Kitagaki, T.; Sato, T.; Takahashi, K.; Tamai, K.; Tanaka, S.; Yamaguchi, A. (Tohoku Univ., Japan). Sci. Rep. Tohoku Univ., First Ser., 50: 41-9(Feb. 1967).

A measurement of the beam contamination in the 7 GeV/c $\bar{p}$

films taken by the BNL 80'' hydrogen bubble chamber was carried out by analyzing the energy spectrum of δ rays (knock-on electrons) with momenta greater than 20 MeV/c. The effective length of tracks may possibly, in practice, be smaller than 125 cm. This difference in track length is small and therefore is neglected. A careful scanning was performed for about 9700 frames of the film, which correspond to about 80 thousand beam tracks. A comparison of the experimental points with theoretical expectation yielded a value for the $(\pi^- + \mu^-)$ contamination in the $\bar{p}$ beam of 97.5 ± 1.5%. Fourteen tracks having a δ ray with large momentum (>54.7 MeV/c) were selected. These beam tracks must have been of π^- or of μ^-. Among the 14 beam tracks, less than 9 beam tracks were of pions; namely, the π/μ ratio of the contamination was less than 64%, because π^- beam tracks were expected to have an interaction vertex along every 10 tracks. (BBB)

36101 A PROPOSAL FOR A NEW DIGITIZER OF BUBBLE CHAMBER PHOTOGRAPHS. Kawaguti, M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 63: 57-60 (July 15, 1968). (BNL-12123).

A fast digitizer of modest cost which is appropriate for automatic analysis of bubble chamber photographs with advanced computers is discussed. (auth)

36102 DESIGN AND PERFORMANCE OF A STREAMER CHAMBER FOR USE IN NEUTRAL BEAMS. Eschstruth, P. T.; Franklin, A. D.; Hughes, E. B.; Gibbs, B. W.; Murphy, F. V.; Reading, D. H.; Wright, K. E. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Nucl. Instrum. Methods, 63: 96-104 (July 15, 1968).

A streamer chamber has recently been operated in a neutral beam at the Princeton–Pennsylvania Accelerator in an experiment to study the decay $K_L^0 \rightarrow \pi^+\pi^-\pi^0$. Because of its extremely light construction (an average thickness of 0.2 g/cm^2), the chamber could be inserted directly into the neutral beam, which consisted of approximately 10^4 neutrons per K_L^0 meson, without generating large numbers of background tracks due to neutron interactions. The events of interest appeared as neutral V's in the chamber and were recorded with the high multiple track efficiency and isotropic detection efficiency characteristic of the streamer mechanism. The chamber was operated in a magnetic field and the tracks were directly photographed in 90° stereo. The construction of the chamber, its operation, and properties such as spatial resolution, sensitive time, and track distortions are discussed. (auth)

36103 DTN–DATA TERMINAL NETWORK COMPUTER SYSTEM. Ophir, D.; Shepherd, B. J. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 62: 285-94 (July 1, 1968). (BNL-12274).

A real time computer system designed for use by the Bubble Chamber Group at Brookhaven National Laboratory is described. Some of the design decisions are discussed, and an attempt is made to generalize some of the criteria used to select the approach employed. After discussing the hardware, the operating system is discussed. First, the necessary responses are outlined. A scheduling algorithm and control transfer structure which meets these performance requirements is then exhibited. Various special services provided to users by the system are listed, and the more important ones are discussed in detail. (auth)

36104 MEASUREMENTS WITH GAMMA BACKSCATTER GAUGE WITH RESTRICTED SCATTERING ANGLE. Taylor, D.; Pirie, E. (Univ. of Strathclyde, Glasgow). Nucl. Instrum. Methods, 62: 341-2 (July 1, 1968).

Experimental tests have been made which demonstrate that, by restricting the scattering angle (φ) to less than ½ π in a gamma backscatter gauge, the soil-type effect is very much reduced. This is in accordance with the theory outlined in an earlier communication. (auth)

36105 SCANNING OF THE SPARK CHAMBER BY MEANS OF A VIDICON. Kantserov, V. A.; Kulyabichev, Yu. P.; Rozov, B. S.; Tereshchenko, B. I. (Inst. of Physics and Engineering, Moscow). Prib. Tekh. Eksp., No. 1, 53-4 (Jan.-Feb. 1968). (In Russian).

The results obtained with the slow cipher television measurement system, designed for scanning of the coordinates with spark chambers were examined. The block diagram of the measurement was given. The resolution obtained is 300 lines on the working platform of the vidicon target (11 × 11 mm^2). The errors in the measurement of the coordinates of the spark are less than 1 mm at the greatest dimension of the spark chamber 200 × 200 × 20 mm^3. (tr-auth)

36106 GARGAMELLE: CERN'S NEW HEAVY LIQUID BUBBLE CHAMBER. CERN Cour., 8: 95-6 (May 1968).

A description of CERN's new heavy liquid bubble chamber, Gargamelle, is given. The chamber is cylindrical and is 1.85 m in diameter and 4.5 m long. The chamber is surrounded by a magnet designed to produce a field of 19 kG. Gargamelle was conceived principally as an instrument for research on neutrinos. (W.H.K.)

36107 PROPORTIONAL COUNTER OF LARGE AREA FOR INVESTIGATION OF COSMIC RADIATION. Vasil'tsov, V. V.; Grigorov, N. L.; Shestoperov, V. Ya. Prib. Tekh. Eksp., No. 1, 73-5 (Jan.-Feb. 1968). (In Russian).

The construction was described and some characteristics were given of the proportional counter of square cross section with dimensions 300 × 11 × 5.5 cm^3. The counter was designed for work with cosmic radiation. (tr-auth)

36108 MAGNETOSTRICTIVE READOUT OF SPARK CHAMBERS IN A MAGNETIC FIELD. Marshak, M. L.; Pruss, S. M. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods, 62: 295-7 (July 1, 1968).

Magnetic fields of moderate strength may cause errors of order 0.5% in measurements made with magnetostrictive spark chamber readouts. (auth)

Radiation Dosimeters

Refer also to abstract 36250.

36109 (BNWL-590) SENSITIVE ALPHA- AND BETA-RAY CALORIMETER. Fleming, D. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 11p. Dep. CFSTI.

A sensitive calorimeter suitable for measuring the power output of small alpha and beta ray sources is described. The calorimeter is of the twin type and is capable of detecting power levels as low as 5×10^{-7} watts. (auth)

36110 (LA-3700) MULTISPHERE NEUTRON-MONITORING TECHNIQUE. Hankins, Dale E. (Los Alamos Scientific Lab., N. Mex.). Mar. 1968. Contract W-7405-eng-36. 31p. Dep. CFSTI.

The multisphere technique is described for converting to dose equivalent the data obtained from the Bonner-sphere neutron detector. The responses from the various sizes of detector are illustrated with data obtained from several sources and critical assemblies. The theory and principles involved in converting these responses to dose equivalent are explained in detail. The multisphere technique is revised to include new calculated response curves which replace the previously used extrapolations in the intermediate-energy region. The accuracy of the technique for an intermediate-energy neutron spectrum which does not follow the 1/E distribution is evaluated. The multisphere technique described does not require a computer analysis. (auth)

36111 (LA-3910) STUDY OF SELECTED CRITICALITY-DOSIMETRY METHODS. Hankins, Dale E. (Los Alamos Scientific Lab., N. Mex.). Dec. 1967. Contract W-7405-eng-36. 56p. Dep. CFSTI.

Several methods for determining the dose received by persons accidentally exposed to a criticality excursion have been investigated. The dosimetry methods included use of film badges, thermoluminescent dosimeters, threshold detector units, Hurst proportional neutron counters, 10-in.-sphere neutron detectors, the multisphere technique, blood-sodium activation, and Geiger counter readings at the abdomen. Five critical assemblies with leakage spectra varying from a fast neutron spectrum to a highly moderated spectrum were studied. The effects of distance from the assembly, room scatter, shielding, and assembly height above the floor were investigated. The results indicate that considerable information must be available before an accurate assessment of a person's dose can be made. If no information about the accident is available, dosimetry using a ratio of the hair and blood-sodium activation will give the dose to within ±20 to 30% except where massive uranium or iron shielding occurs. (auth)

36112 (SZS-6/68) ERMITTLUNG DER PERSONENDOSIS VON ROENTGEN-, γ UND β-MISCHSTRAHLUNG MIT DEM DDR-DOSIMETER. (Determination of the Personal Dose of Roentgen-γ- and β Mixed Radiation with the DDR Dosimeter). Schaup, K. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Feb. 1968. 34p. (In German). Dep.

For the estimation of individual dose by means of the D.D.R. dosimeter a compensation method is described which was developed for personnel dose measurement in mixed x-ray, gamma-ray, and beta-radiation fields of unknown composition. The method is suitable for automatic evaluation of the film dosimeters. The

dose is determined from a linear function either of densities or of apparent doses. Indications are given of the practical use. The energy dependence of the method is between −40% and +50% for quantum energy ranging from 12 keV to 2 MeV and between −30% and +100% for maximum beta energy ranging from 0.4 to 3 MeV. The direction dependence of the dosimeter is compensated to a certain degree. (auth)

36113 IMPROVEMENTS IN OR RELATING TO DOSIMETERS. (to Electrospace Corp.). British Patent 1,115,809. May 29, 1968. Priority date July 16, 1965, United States.

A dosimeter for measuring total dose from gamma rays, x rays, and fast neutrons is described. A thermoluminescent dosimeter and a silicon diode are housed in a small cylindrical casing for convenience in handling and reading. (W.H.K.)

36114 THERMOLUMINESCENT DOSIMETRIC DEVICE. Kudelin, K. M.; Bulgakov, V. B.; Lebedev, A. A. (State Inst. of Measurement and Measurement Devices, Novosibirsk, USSR). Prib. Tekh. Eksp., No. 1, 69-71 (Jan.-Feb. 1968). (In Russian).

A thermoluminescent dosimeter for measurement of γ and x radiation with energy from 0.02 to 1.3 MeV in the dose range from 0.005 to 10^4 R was described. The variation with hardness does not exceed ±15%. The error in the 24 hrs after irradiation is 8 to 10%. (tr-auth)

36115 EFFECT OF GAMMA IRRADIATION UPON GLYCOL–BENTONITE AND APPLICABILITY OF IRRADIATION EFFECT TO GAMMA DOSIMETRY. Yamamoto, Daisei (Kumamoto Univ., Japan). Clay Sci. (Tokyo), 2: 147-50(1966).

A glycol complex of montmorillonite and a powerful ^{60}Co source (16 kCi) were used in the experiment. Diffusion of the powder-line was observed when the glycol complex was irradiated with γ rays up to above 2×10^5 R, and the diffusion became remarkable with the total dose used. A working curve was obtained by plotting the correlation between the half width of the reflection and the total radiation dose. The applicability of the curve to γ dosimetry was found in the range from (2.0 to 6.0) $\times 10^3$ R. Compared with the diffusion of the reflection, the c-spacing change due to the irradiation was too small for the purpose. The change in c-spacing of the samples became remarkable in relation to the doses of about 6×10^5 R. (NSA of Japan)

36116 PRESENT STATUS OF LUMINESCENCE DETECTORS AND COMPARISON WITH THE PHOTOGRAPHIC SYSTEM IN PERSONAL DOSIMETRY. Carfi, N. (Laboratori CISE, Milan); De Franceschi, L. Energ. Nucl. (Milan), 15: 381-8(June 1968). (In Italian).

In the last years new solid state systems have been developed, which make use of thermoluminescent crystals (Thermo Luminescent Disimetry, TLD), or photoluminescent glasses (Photo-Luminescent Dosimetry, PLD). The properties are analyzed of the principal crystals and metaphosphate glasses respectively used in the two above systems. The various dosimeters which have been conceived are examined from the point of view of their practical applications; in particular their versatility and their commonest range of use—namely personal dosimetry—are evaluated. At last they are compared with the photographic system and the conclusion is that presently no system can be considered as ideal, or having all the requirement needed: however TLD and PLD systems—within enough large limits—are to be considered better than the photographic one. (auth)

36117 BASIC γ-RAY DOSIMETRY. Attix, F. H. (Naval Research Lab., Washington, D. C.). Health Phys., 15: 49-56(July 1968).

In order to carry out meaningful dosimetry it is first necessary to decide what is to be measured, and then to choose the best method of measurement. It is often not easy to answer even the first, apparently trivial, question. It requires at least an understanding of the 2-step process by which γ-rays deposit energy in matter, and of the concepts of charged-particle equilibrium, air (or tissue) equivalence, energy dependence, fluence, kerma, absorbed dose, and exposure. (auth) (UK)

36118 EXPERIENCE WITH A COMMERCIAL FILM BADGE SERVICE. Schimmerling, W.; Sass, R. E. (Princeton Univ., N. J.). Health Phys., 15: 73-82(July 1968).

The performance of a commercial film badge service was studied over a period of 3 yr. Known doses were administered to 800 film badges in this time, and the reported results analyzed. The accuracy and reliability of the film badge service's reported neutron doses was investigated and a statistically meaningful measure of reliability was established. It was found that reported doses overestimated the doses actually given. The year-to-year performance of the supplier was satisfactory. No seasonal variations were observed. It is considered that the testing procedure provides for a suitable reference in the event that the film badge service is discontinued. Track fading was seen to exist. None of the film packaging procedures was found to be effective in retarding latent image fading. The accuracy of the beta-gamma film was studied by comparison of the film badge service's reported doses with known beta and gamma doses given. Due to the necessarily arbitrary level of separation of beta from very soft gamma exposures, the beta + gamma results were found to be more accurate than each separately, as was to be expected. A further comparison was made of reported gamma exposures and accumulated readings from pocket ionization chambers used at the Princeton-Pennsylvania Accelerator for auxiliary day-to-day monitoring. Results were in reasonable agreement. Some of the problems inherent in neutron dosimetry in the vicinity of high energy accelerators are discussed. The need for improved neutron personnel dosimeters is considered and the relation of film badge readings to personnel dose is briefly discussed. (auth) (UK)

Radiometric Instruments

Refer also to abstract 36050.

36119 MEASURING THE SURFACE DENSITY AND THICKNESS OF SHEET AND FILM MATERIALS. Fedotov, Igor Leonidowich; Yanushkovskii, Vladimir Alexandrovich; Taksar, Egoshua Mikhailovich; Olshvanger, Boris Akibovich. (to Rizhskii Filial Vsesoiuznogo Nauchno-Issledovatelskogo Instituta Radiatsionnoy Tekhniki). British Patent 1,112,123. May 1, 1968. Filed June 25, 1965.

A radiometric system for measuring the surface density or thickness of sheet or film material is described. A standard source of beta radiation is allowed to penetrate the material, then it is back-scattered by the ambient medium behind the material, and then the intensity of the back-scattered beta radiation is measured. (W.H.K.)

36120 LIGHTNING WARNING PROBE UTILIZING A RADIOACTIVE IONIZING ELEMENT. Able, Edward T. (to B. K. Sweeney Mfg. Co.). U. S. Patent 3,384,747. May 21, 1968. Filed Sept. 8, 1964.

A lightning warning system for continuously monitoring the atmospheric voltage gradient to detect atmospheric conditions that could produce lightning is described. A radioactive ionizing element and a metallic cup-shaped cap are designed to act as an ionizing chamber and measure the electric potential gradient. (W.H.K.)

36121 IMPROVEMENTS IN AND RELATING TO THE MEASUREMENT OF THE DENSITY OF THE FLUID COOLANT FROM A NUCLEAR REACTOR. (to Atomic Energy of Canada Ltd.). British Patent 1,115,850. May 29, 1968. Priority date Aug. 26, 1966, United States.

A neutron radiometric device is described for measuring the density of fluid coolants from a nuclear reactor and under ideal conditions indicates coolant quality. (B.G.D.)

Miscellaneous Instruments and Components

Refer also to abstracts 36168, 36453, 36796, and 37620.

36122 (CONF-680303) PROCEEDINGS OF THE NOISE REDUCTION CONFERENCE AT LAWRENCE RADIATION LABORATORY, UNIVERSITY OF CALIFORNIA, LIVERMORE, CALIFORNIA, MARCH 5–7, 1968. (California Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 251p. Dep. CFSTI.

Separate abstracts were prepared for 4 of the 22 papers presented. (W.H.K.)

36123 (CONF-680303–, pp 235-8) NOISE PROBLEMS IN REACTOR INSTRUMENT SYSTEMS. Pearson, T. (General Electric Co., San Jose, Calif.).

Principal sources of noise are ground loops and switching transients. Radio frequency interference is a problem during construction and nonoperating periods. Different methods of noise reduction must be used for low impedance pulse or mean square voltage systems and for high impedance DC systems. Switching transients have been more of a problem in DC systems than in pulse systems, mostly due to near 1 MHz low frequency dropoff in the latter's amplifiers. Use of multiple shielded cables has proven effective for low impedance systems while anti-noise treated cables have been effective for high impedance systems. RC network or other arc suppressors across relay or solenoid coils have eliminated

their transients. Ground loops have been avoided by sensor isolation. General Electric nuclear instruments are designed and tested to MIL-I-26600 susceptibility requirements and have needed little on-site modification to reduce noise pickup. Most problems have been solved by noise reduction techniques external to panel-mounted drawers, modules or pages. (auth)

For abstracts of individual papers see: 36027, 36028, 36078, and 36123.

36124 (KR-125) FLIPPER-CHOPPER FOR POLARIZED SLOW NEUTRONS. Virjo, A.; Steinsvoll, O. (Institutt for Atomenergi, Kjeller (Norway)). Feb. 1968. 76p. Dep.

By suitably varying the parameters (main field, r.f. current strength, or frequency) of a neutron spin resonance flipper ordinarily used in diffractometers for polarized slow neutrons, it is possible to pulse the flipper into or out of resonance for short periods. One thus obtains short bursts of neutrons with reversed polarization. A device operating as above is called a flipper-chopper. The bursts can then be used in connection with the time-of-flight method to measure the scattered neutron energy for the polarization dependent part of a scattering process, that takes place after the flipper-chopper. We have investigated the theory of the flipper-chopper with the help of a simplified model, where the neutron beam is assumed to be limited to the symmetry axis of the flipper coil. The flipper coil geometry may be arbitrary in other respects, but the field produced by it (on the symmetry axis) must be directed along the axis. The main magnetic field has been assumed homogeneous in direction, but can be otherwise arbitrary. Three possible flipper-chopper principles (according to the modulation method) are discussed, paying special attention to resolution, namely main field pulsing, r.f. current pulsing, and main field sweeping. A prototype using main field pulsing has been built and successfully tested. The results do not, however, agree quantitatively very well with theory, e.g., the smallest pulse widths achieved have been ≈1.5 times greater than the theory predicts. The probable reasons for this are discussed. The theory should in any case be at least qualitatively useful in flipper-chopper construction. (auth)

36125 (LA-3930) SEMIANNUAL ATOMIC ENERGY COMMISSION COMPUTER INFORMATION MEETING, MAY 20-21, 1968. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. 70p. (CONF-680511). Dep. CFSTI.

Summaries of recent research and developments at the various AEC computer centers are presented. (W.H.K.)

36126 (LA-3930(Suppl.)) SEMIANNUAL ATOMIC ENERGY COMMISSION COMPUTER INFORMATION MEETING MAY 20-21, 1968. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. 76p. (CONF-680511(Suppl.)). Dep. CFSTI.

Summaries of recent research and developments at various AEC computer centers are presented in addition to those presented in report LA-3930. (W.H.K.)

36127 (ORNL-TM-1638(Pt.9)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 9. FAST TRIP COMPARATOR, ORNL MODEL Q-2609. Anderson, J. L. (Oak Ridge National Lab., Tenn.). Mar. 25, 1968. Contract W-7405-eng-26. 27p. Dep. CFSTI.

The circuit, application, maintenance procedures, and acceptance tests for a fast trip comparator are described. The comparator is intended for use in the safety or control systems of nuclear reactors to provide voltage level discrimination of safety or control signal inputs. The circuit is bistable in nature; that is, there is no change in output indication until the predetermined trip level is exceeded, at which time the output suddenly changes from one state to the other. Both logic-level and relay outputs are available. By simple jumpering of connector pins, the circuit can be arranged for either positive or negative inputs with either increasing or decreasing sense. The comparator is packaged in a standard one-unit plug-in module of the ORNL Modular Reactor Instrumentation Series, Q-2600. (auth)

36128 (ORNL-TM-1638(Pt.25)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 25. 32 v dc TO 115/6.3 v, 60 cycle INVERTER, ORNL MODEL Q-2625. Anderson, J. L. (Oak Ridge National Lab., Tenn.). Apr. 26, 1968. Contract W-7405-eng-26. 13p. Dep. CFSTI.

The 32-v dc to 60-cycle inverter is a dc-to-ac inverter that operates from an input of +28 to +36 v dc and delivers outputs of 115 v and 6.3 v, rms, square wave, 60 Hz. The 115-v output has a 25-w capacity and the 6.3-v output is rated at 10 w. The inverter is a standard plug-in module of the ORNL Modular Reactor Instrumentation Series. The circuits, application, maintenance procedures, and acceptance tests for the unit are described. (auth)

36129 (ORNL-TM-2214) A COMPUTER-AIDED STUDY OF A 600 MHz DECADE SCALING SYSTEM. Reedy, Edward Kyle (Oak Ridge National Lab., Tenn.). Aug. 1968. Contract W-7405-eng-26. 197p. Dep. CFSTI.

Thesis.

The primary objective of this study was to survey, evaluate, and compare the high-speed properties of existing scaling techniques to determine the feasibility of building a completely transistorized counting or scaling system capable of accepting and correctly handling input signals having fixed frequency or equivalent aperiodic repetition rates above 500 MHz. An auxiliary or secondary objective of this study was to illustrate the application of generalized circuit analysis computer programs in a high-speed circuit design problem. A comprehensive examination of several direct scaling techniques, with particular emphasis placed on the high-frequency limitations inherent in each technique, indicated that the maximum overall scaling rate for all circuits considered, with the exception of the twisted ring and Engelmann, was limited to the maximum scaling rate of the first binary stage in the system. Conflicting input pulse requirements (high pulse energy coupled with narrow width) forced the exclusion of the twisted ring scheme from further consideration. Due to its simplicity and promise of high-speed, a quibinary scaler, employing an Engelmann type quinary, was selected as warranting further investigation for 500 MHz. (and above) decade scaling systems. A computer-aided (using the ECAP and NET I circuit analysis programs) investigation and correlation of the stability and switching characteristics of current-mode circuits resulted in a number of important conclusions. The most important of these was that reducing the differential bias voltage between the bases of the transistors which form the switch decreases the transient time for a C-M circuit without sacrificing circuit stability. This speed-up technique was experimentally confirmed in a modified current-mode switch. A modification of Engelmann's original circuit incorporating the current-mode speed-up technique was proposed. To avoid layout and parasitic parameter effects, a computer comparison of an optimized standard Engelmann circuit and modified scaler, called a DCM scaler, was made. An increase of thirty-five percent (from 625 MHz. to 835 MHz.) was observed in the scaling speed of the DCM scaler over that of the Engelmann. In addition, an equivalent double-pulse repetition rate of 600 MHz. was reached, experimentally, using a prototype of the DCM scaler. This study has established that scaling systems capable of speeds above 500 MHz. are certainly feasible. In addition, an improved scaling circuit which can extend direct scaling rates to frequencies above 800 MHz. was proposed. With improved circuit construction techniques and higher-speed transistors, the upper frequency limit of the DCM scaler could be extended to one gigahertz or more. (auth)

36130 (RISO-M-667) BERETNING OM ARBEJDET I ELEKTRONIKAFDELINGEN I TIDEN 1. JULI TIL 30. SEPTEMBER 1967. ([Electronics]. Quarterly Report for the Period July 1-September 30, 1967). (Danish Atomic Energy Commission, Risoe. Research Establishment). Dec. 1967. 29p. (In Danish). (R-25-67). Dep.

A summary is given of some departmental activities: display former for DR-2, preliminary specification of CRT display subsystem, system programmer for PDP-8, HPI high-pressure type instrumentation, grounding of research installation, hybrid computer programs, frequency characteristic program of the PDP-8, and an example of the design of a hybrid computer for solution of integration problems. (J.S.R.)

36131 (WAPD-TM-724) FEEDBACK SYSTEM CONCEPTS. Bean, W. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1968. Contract AT(11-1)-Gen-14. 225p. Dep. CFSTI.

Thirteen lectures dealing with feedback system concepts are presented. These lectures conprise the first half of a course in nuclear reactor plant dynamics and control in the Bettis Reactor Engineering School of the Bettis Atomic Power Laboratory, Pittsburgh, Pennsylvania. The basic principle of feedback is introduced, and then the conversion of physical systems to mathematical descriptions illustrated. Transfer functions, block diagrams and signal flow graphs are developed and used with numerous simple examples. The concept of stability is introduced, and several lectures are devoted to stability criteria and analysis, both from the characteristic equation approach of the Routh array and the open loop frequency response methods of Nyquist and Bode. Time domain behavior is studied and correlated with complex plane root locations. Both transient response and sinusoidal steady state response are characterized, and compensation-stabilization principles outlined. The first eleven lectures deal solely with linear systems. The last two lectures present an approach for analyzing some types of nonlinear systems: the small departure or perturbation method, and the large departure or describing function method. (auth)

36132 TWO-STAGE PRESSURE CONTROL SYSTEM FOR FITTING TO A CREEP MEASURING CELL. Bret, Antoine; Marinot, Robert (to Commissariat a l'Energie Atomique). British Patent 1,115,709. May 29, 1968. Priority date July 24, 1965, France.

A control system for a creep measuring cell which is composed of a bellows-type pneumatic jack loading system and strain gage for continuous deformation measurements is described. The system controls the pressure acting on the pneumatic jack loading system and is comprised of a control valve, a tank connected to the creep measuring cell, a return line to the compressor intake, and a pressure control loop made up of a pressure pick-up connected to the strain gage, a function generator controlled by the pick-up, and a pressure controller actuated by the generator. (W.H.K.)

36133 BIOMEDICAL SCIENCES INSTRUMENTATION. VOLUME 4. ADVANCES IN DYNAMIC BIOINSTRUMENTATION FOR MEDICINE AND RESEARCH. Proceedings of the Fifth National Biomedical Sciences Instrumentation Symposium, Held May 15–17, 1967, Albuquerque, New Mexico. Allison, R. D. (ed.). A Publication of Instrument Society of America. New York, Plenum Press, 1968. 346p. (CONF-670514).

One of the 44 papers presented is abstracted in NSA. The other 43 papers were not sufficiently within the scope of NSA to be included. (W.H.K.)

For an abstract of the individual paper see: 36039.

36134 KURZZEITPHYSIK. (High-Speed Physics). Vollrath, K.; Thomer, G. (eds.). Wien, Springer-Verlag, 1967. 1087p. (In Several Languages).

Bibliographic reviews are presented in the following areas: oscilloscopes and amplifiers, flash light sources and high-frequency flash photography, lasers, electro-optical shutters, scanning methods for high frequency photography, radiographic techniques, radioelectric methods for high speed physics, temperature measurement, brittle fracture control by elastic waves, high speed physical testing of very fast metal deformations, dynamic photoelasticity, impact at intermediate velocities involving contact phenomena, hypervelocity impact, launching of high speed projectiles, shock waves in gases, measurements in hypersonic shock tunnel, explosion physics, fast chemical reactions–gas explosions, high-speed methods in nuclear physics, and high-speed measurement methods in plasma physics. Separate abstracts were prepared for the last two chapters. (W.H.K.)

For abstracts of individual chapters see: 36045 and 36899.

36135 PULSE SHAPE DISCRIMINATION WITH A P-I-N SOLID STATE DETECTOR. Abe, K.; Kawamura, N.; Mutsuro, N. (Tohoku Univ., Sendai). Nucl. Instrum. Methods, 63: 105-8 (July 15, 1968).

A new technique of pulse shape discrimination with a single p-i-n solid state detector is described. The technique was found suitable for the identification of photoprotons in the strong gamma-ray and electron background in photoreactions by bremsstrahlung x rays. (auth)

36136 PULSE HEIGHT ANALYZERS: COMPUTER-COMPATIBLE OUTPUT FOR BOTH STATIONARY AND MOBILE SYSTEMS. Euler, B. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods, 63: 29-38 (July 15, 1968).

As the utilization of digital computer techniques for the analysis of pulse height spectra increases, it is important to develop efficient and reliable techniques for linking the pulse height analyzer to the computer. Two computer-compatible analyzer output media, punched cards and magnetic tape, have been found to be practical and appropriate for providing computer coupling for an array of pulse height spectrometers which are used for making high-quality measurements in gamma-ray spectrometry. Both stationary and mobile installations have been accommodated. An IBM-523 Gang Summary Punch, in conjunction with a specially built buffer unit, is used to provide fast punched card readout from 256-, 1024-, and 16384-channel pulse height analyzers. Computer-compatible magnetic tape readout is provided on a 4096-channel and a 16384-channel pulse height analyzer. (auth)

36137 MAGNETIC LENSES WITH SUPERCONDUCTING WINDINGS IN ELECTRON MICROSCOPY. Genotel, Denis; Severin, Claude; Laberrigue, Andre (College de France, Paris). J. Microscop., 6: 933-44 (Dec. 1967). (In French).

Optical characteristics of magnetic lenses usable in electron microscopy are presented for accelerating potentials up to 5 MeV. Several types of lenses are studied. For all examples studied, the exciting winding is superconducting Nb-Ti wire; different geometries are employed for the ferromagnetic core. For one of these, the ferromagnetic core is suppressed and replaced by hollow superconducting cylinders used as perfect magnetic filters. One of the best characteristics obtained is: $f_{obj} = 6$ mm for an accelerating potential of 5 MeV. Data for electron trajectories are given along with theoretical considerations. If $(NI)_m$ is the maximum number of amp-turns for a lens L, the maximum number for L_k will be k^2NI even if kNI alone is necessary to have with L_k the maximum field obtained with L. It is of interest to construct a lens for which the exciting winding has smaller diameter than that of the lens L_k to improve optical characteristics. (BBB)

36138 ELECTRON-CAPTURE DETECTORS IN GAS CHROMATOGRAPHY. Charles, D. R. Bio-Med. Eng., 2: 122-6 (Mar. 1967).

An electron-capture detector is a chamber formed between 2 electrodes. The cathode is made of slightly radioactive material, usually tritium foil, and the carrier gas flows through the chamber from the anode to the cathode. The tritium foil emits β particles at a constant rate of $\sim 7.4 \times 10^9$ particles per sec. Consequently, if a suitable positive potential is applied at the anode, the electrons will move to the anode and in theory a current of about 10^{-9} A will be obtained. However, in practice, secondary electrons are produced by collisions between the emitted primary electrons and molecules of the carrier gas, giving a steady average current of between 10^{-8} and 10^{-9} A, depending on the molecular stability of the carrier gas. Positive ions are produced at the same time, and these heavier particles also contribute to the total current; however, this effect can be eliminated. Although other radioactive source materials such as Ra-D and ^{90}Sr have been used, a 200-mCi tritium source is considered best for most applications. The radiation hazard is negligible since the ionizing radiation has a very short range and the energy is all dissipated within the detector. Additional shielding is not necessary. (BBB)

36139 TRANSISTORIZED HIGH-VOLTAGE PULSE GENERATOR. Zheltov, K. A.; Mishin, V. M. Prib. Tekh. Eksp., No. 1, 128-9 (Jan.-Feb. 1968). (In Russian).

A transistorized generator for high-voltage pulses with amplitude ~25 kV and repetition from 0.5 to 400 Hz was described. (tr-auth)

36140 MASS SPECTROMETER WITH IONIZATION OF MOLECULES BY STRONG ELECTRIC FIELDS AND ELECTRON COLLISIONS. Korostyshevskii, I. Z.; Gol'denfel'd, I. V. (Inst. of Physical Chemistry, Kiev). Prib. Tekh. Eksp., No. 1, 146-8 (Jan.-Feb. 1968). (In Russian).

The design of an ion source combining two molecules ionization methods, strong electric fields, and electron collisions, is proposed for mass spectrometers of the MI type. (B.G.D.)

36141 IMPROVEMENT OF THE TIME RESOLUTION OF THE ANALYZER BY MEANS OF AN AMPLITUDE CORRECTION CIRCUIT. Averchenkov, V. Ya.; Nefedov, Yu. Ya.; Gvozdev, V. Ya. Prib. Tekh. Eksp., No. 1, 80-7 (Jan.-Feb. 1968). (In Russian).

A two-channel amplitude correction circuit for the time analyzer, working on the principle of the conversion of time into amplitude, was described. With the correction circuit, a time resolution of 5.2×10^{-10} sec was obtained with use of the FEU-36 with a plastic scintillator ϕ 40 × 40 mm^2 and efficiency of coincidence registration of ~70%. The introduction of diode stops in the circuit eliminates to a significant degree faults inherent with previously published circuits of this type. In measurements with Po + Be sources the possibility was shown of using the circuit for the registration of the time distribution of γ quanta and neutrons of the continuous spectra. (tr-auth)

36142 CHROMATIC ABERRATION IN A MASS SPECTROMETER WITH STEPPED HOMOGENEOUS MAGNETIC FIELD. Karataev, V. I. (Inst. of Physics and Tech., Leningrad). Prib. Tekh. Eksp., No. 1, 152-3 (Jan.-Feb. 1968). (In Russian).

The measurement of the chromatic aberration in a two-stage mass spectrometer with π-radian focusing of the ions in each stage was described. It was shown that with a given ratio of the voltage of the electric and magnetic fields chromatic aberrations of the first order are absent. (tr-auth)

36143 INTRODUCTION IN THE MASS SPECTROMETER OF SAMPLES IN THE FORM OF MOLECULAR BEAMS. Aleksandru, Gr. (Inst. of Atomic Physics, Bucharest). Prib. Tekh. Eksp., No. 1, 154-5 (Jan.-Feb. 1968). (In Russian).

A system for the introduction into the mass spectrometer of samples in the form of molecular beams was described. The system makes possible measurements in the presence of residual background. (tr-auth)

36144 LEVELING OUT SYSTEM OF A MULTI-CHANNEL ANALYZER WITH MEMORY OF THE COMBINATION TYPE.

Gerasimov, B. Ya.; Ivchenko, V. E.; Smirnov, V. I.; Chernukhin, V. L. Prib. Tekh. Eksp., No. 1, 87-92 (Jan.-Feb. 1968). (In Russian).

A two-stage ferrite system for the leveling out of the numerical code for multichannel analyzers with memory of the combination type, consisting of ferrite memory installations and recording on magnetic tape, was described. The leveling out installation performs two functions in the analyzer: reduction of the information loss and guarantee of the maximum filling of the magnetic tape. The system was calculated for work with pulse data sources and can store simultaneously up to ninety 27-discharge codes, during which the consideration of the code is accomplished by a series of pulses. The dead time of the leveling out installation is 4 μsec. (tr-auth)

36145 INTEGRAL AND DIFFERENTIAL DISCRIMINATOR WITH TUNNEL DIODES. Budyashov, Yu. G.; Zinov, V. G. (Joint Inst. of Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 1, 92-6 (Jan.-Feb. 1968). (In Russian).

The integral and differential amplitude discriminators with tunnel diodes, whose recovery to the initial state after use is produced with signals of delayed negative reverse coupling, were described. The absence of reactive elements in the loading chain of the tunnel diode causes the wear threshold to be independent of the growth rate of the front of the input pulses. In the differential time discriminator the insensitivities of the lower and upper channels after wear are similar which makes it possible to eliminate errors of the anticoincidence circuit with large charge. (tr-auth)

36146 TUBES FOR LOW-NOISE PREAMPLIFIERS. Brovchenko, V. G.; Molchanov, Yu. D. Prib. Tekh. Eksp., No. 1, 120 (Jan.-Feb. 1968). (In Russian).

In the first cascade of a pulse amplifier, the tube 6N27P was recommended. The natural noise of the amplifier, collected in this tube, is 1.4 keV. By coupling of a capacity of 15 nF to the condenser input, the noise is increased to 2.5 keV. (tr-auth)

36147 SMALL-DIMENSION GENERATOR OF HIGH VOLTAGE SINGLE PULSES. Belkin, N. V.; Tarasov, M. S. Prib. Tekh. Eksp., No. 1, 121-3 (Jan.-Feb. 1968). (In Russian).

The operational principles and the construction of the high-voltage pulse generator with 100 to 500 kV amplitude, having a form close to rectangular, were described. The test results of one of the generator models, giving pulses of 5 μsec duration with amplitude up to 200 kV, are given. (tr-auth)

36148 TRANSISTORIZED THREE-CHANNEL GENERATOR OF NANOSECOND PULSES. Vasil'ev, E. A.; Denisov, A. S.; Kruglov, S. P.; Suvorov, V. M. (Technical Inst. of Physics, Leningrad). Prib. Tekh. Eksp., No. 1, 123-5 (Jan.-Feb. 1968). (In Russian).

The circuit of a three-channel generator of nanosecond pulses, working in the regime of pulse series or in the regime for formation of nanosecond pulses from a sinusoidal input, was described. The generator is used for supply and pulse insertion. (tr-auth)

36149 LOCATION METER OF THE MEDIAN MAGNETIC SURFACE IN INSTALLATIONS WITH CONSTANT INHOMOGENEOUS FIELDS. Kizilov, V. U.; Skubko, V. A.; Tolstoi, A. E. (Inst. of Physics and Tech., Kharkov). Prib. Tekh. Eksp., No. 1, 177-81 (Jan.-Feb. 1968). (In Russian).

A meter for locating the median surface of inhomogeneous magnetic fields incorporating a Hall effect transducer was used to determine the geometric position of the zero radial components of magnetic surfaces in installations with constant inhomogeneous fields. The meter can be used for measurements in weak fields. The principal circuits of the meter and the fabrication of the transducer were described. A method for the first calibration of the transducer and control of its orientation in the measurement process was explained. (tr-auth)

36150 HIGH-POWER PULSE GENERATORS IN FOUR-LAYER DEVICES OF THE PN PN TYPE. Onischenko, V. M. Prib. Tekh. Eksp., No. 1, 5-11 (Jan.-Feb. 1968). (In Russian).

High-power pulse generators in four-layer devices of the PN PN type, used as modulators and current switches, were examined. The disconnecting properties of four-layer diodes and triodes were described. Some circuits were introduced and described. (tr-auth)

36151 MAGNETOMETER WITH HALL EMF TRANSDUCER. Bordo, G. V.; Litunovskii, R. N. (NII Electrophysical Apparatus, Leningrad). Prib. Tekh. Eksp., No. 1, 181-2 (Jan.-Feb. 1968). (In Russian).

A device for the measurement of the intensity of magnetic fields from 2 to 20 kOe with a Hall transducer as the sensitive element was described. Rectifying elements were introduced into the magnetometer after the separating transformer, and all circuits were realized with symmetrical circuits. The precision of the device is $\pm 2 \times 10^{-4}$. (tr-auth)

36152 HIGH-SPEED 4096-CHANNEL ANALOG-DIGITAL CONVERTER FOR PULSE HEIGHT ANALYSIS. Robinson, L. B.; Gin, F.; Goulding, F. S. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 62: 237-46 (July 1, 1968). (UCRL-17419).

A 12-bit analog-digital converter of the successive binary approximation type is described. The unit accepts input pulses less than 1 μsec long and produces a 12-bit digital output in a register in less than 25 μsec. Use of the random pedestal technique described by Gatti and careful design results in essentially equal channel widths from channel 40 to 4000. Integrated circuits are used for all digital operations, producing a compact unit despite the circuit complexity of the successive approximation technique. The unit is designed for convenient linking to a computer using either its program interrupt or direct memory access facilities, but can be operated equally well with any memory unit. (auth)

36153 A PDP-8 COMPUTER CONTROL SYSTEM. Abbattista, N.; Anelli, E. F.; Marino, D.; Plantamura, V. L. (Univ., Bari, Italy). Nucl. Instrum. Methods, 62: 337-40 (July 1, 1968).

We describe a control system assembling a data acquisition unity on-line with a PDP-8 computer as feedback element of external devices. The acquisition is performed by means of a matrix ordering; some status words are provided for a data prefiltering. (auth)

36154 POLARIMETER FOR ISOBARIC ANALOG STATE SPIN MEASUREMENTS. Maxson, D. R.; Jolly, R. K.; Knox, K. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 62: 276-84 (July 1, 1968).

A double scattering apparatus for isobaric analog state spin measurements has been developed. The investigations show that with a properly designed polarimeter, laboratories without a polarized beam can make such measurements in a few hours. Examples of spin measurements with the present apparatus are presented. (auth)

Radiation Effects on Instruments and Instrument Components

36155 (BNWL-749) NUCLEAR RADIATION INDUCED CURRENTS IN COAXIAL SIGNAL CABLES. Stringer, J. L.; Bourassa, R. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1968. Contract AT(45-1)-1830. 54p. Dep. CFSTI.

A qualitative model parametrically relating the nuclear radiation induced current in a coaxial cable to the cable materials, dimensions, and radiation flux intensity has been developed. The model will predict induced current polarities for each component of the nuclear radiation field. Experimental data indicating induced currents per unit length up to 4×10^{-8} A/cm as measured in a 0.250 in. OD coaxial cable placed in a TRIGA reactor is presented. The change in polarity of the induced current found in these experiments is described by the model. An interpretation based on this model is presented for other previously unexplained experimental data. (auth)

36156 (N-68-15364) LOW-ENERGY PROTON DAMAGE EFFECTS IN SILICON SURFACE-BARRIER DETECTORS. Coleman, J. A.; Love, D. P.; Trainor, J. H.; Williams, D. J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1967. 26p. (NASA-TM-X-63082; X-611-67-638). CFSTI.

In order to predict the useful lifetime of semiconductor detectors which operate in the Earth's trapped radiation belts, the effects of damage by 50 keV, 200 keV, 600 keV, and 1 MeV protons on silicon, surface-barrier, transmission detectors have been studied for fluences from 10^{10} to 10^{14} protons/cm^2. Detector current, noise and capacitance increased with fluence, with significant increases occurring after 10^{13} protons/cm^2. Bias-voltage-dependent multiple peaking was observed with Am-241 alpha particles. The effects of damage by protons with these low energies are significantly reduced in transmission detectors if the protons enter the rear, aluminum contact rather than the front, gold contact. (auth) (STAR)

36157 (N-68-17065) RECOVERY FROM RADIATION DAMAGE IN SOLAR CELLS DOPED WITH LITHIUM. Annual Report, June 21, 1966-June 20, 1967. Wysocki, J. J.; Brucker, G. J.; Holmes-Siedle, A. G. (Radio Corp. of America, Princeton, N. J.

Astro-Electronics Div.). Contract NAS5-10239. 75p. (NASA-CR-93138). CFSTI.

The effect of lithium in producing recovery in silicon solar cells irradiated with high-energy particles was further investigated. A better understanding of the processes involved is emerging; recommendations for optimizing cells for radiation resistance and suggestions for future study have been made. The main technique used to gain understanding was the study of isothermal recovery of test diodes and of government-furnished cells. Recovery appears to follow a diffusion-limited kinetic model in which unequal concentrations of the annealing species are present. It is reasonably well established that the speed and extent of recovery depend critically upon the amount of free or unpaired lithium diffusion. The damage site is still considered to involve lithium, and recovery is still thought to be associated with diffusion of another lithium ion to, and subsequent pairing with, the damage site. Among results which are not yet fully understood is the fact that diffusion length after bombardment is not dependent upon the initial value of lithium concentration. (auth) (STAR)

36158 (N-68-22226) ELECTRON RADIATION EFFECTS ON SILVER-ZINC CELLS. Palandati, Charles F. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1968. 13p. (NASA-TM-X-63170). CFSTI. NSA

A test has been completed to determine the effects of electron irradiation on vented silver-zinc (Ag-Zn) cells, similar to the type used in the AE-B (Explorer 32) spacecraft. Irradiation by electrons of energies up to 1.5 MeV at 10^{14}e/cm^2 caused severe deterioration of the cellophane separator material producing catastrophic cell failures. Half of the cells irradiated at 10^{14}e/cm^2 failed after being subjected to numerous charge-discharge cycles. No cell failures occurred at 10^{13}e/cm^2. Results also indicated that a cell's state of charge during irradiation may affect its ampere-hour capacity. (auth) (STAR)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 36237, 36306, 36307, 36325, 36358–36360, 36386, 36392, 36393, 36399, 36402, and 37628.

36159 SEROLOGICAL PROPERTIES OF PORCINE TRYPSIN SUBSEQUENT TO INACTIVATION BY VARIOUS METHODS. Ghiron, C. A.; Barrett, J. T.; Humber, J. Y. (Univ. of Missouri, Columbia). Contract AT(11-1)-1667. Photochem. Photobiol., 7: 87-92(Jan. 1968). (COO–1667-1).

Porcine trypsin was inactivated by various methods (heat, autolysis, photodynamic action, ultraviolet light, and gamma-radiation) and the inactivated products were tested for their ability to precipitate porcine trypsin antiserum using the capillary fluid precipitin method. It was found that the chemical and structural modifications incurred with irradiation, sufficient to inactivate porcine trypsin, in contrast to heat and autolysis, did not interfere with those parts of the protein surface required for immunochemical reactivity. (auth)

36160 PHOTOCHEMISTRY OF BIOLOGICAL MOLECULES. II. PHOTOLYSIS OF DIPEPTIDES IN THE SOLID STATE. Johns, R. B.; Looney, F. D.; Whelan, D. J. (Univ. of Melbourne, CSIRO, Melbourne). Photochem. Photobiol., 7: 65-72(Jan. 1968).

Photolysis with light of 2537 Å of a series of aliphatic dipeptides in the solid state was shown to lead to bond rupture and free radical formation. The structures of the radicals were determined by ESR techniques and in general, the free electron was shown to reside on the carbon atom attached to the nitrogen atom of the peptide bond. Dipeptides containing phenylalanine residues show ESR spectra typical of the free amino-acid in the terminal position. (auth)

36161 EFFECT OF UV-IRRADIATION ON SEDIMENTATION BEHAVIOR OF VARIOUS PROTEINS. Dose, Klaus; Sena, Luigi (Univ. of Naples. Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Photochem. Photobiol., 7: 59-64(Jan. 1968).

Moderate uv-doses (2537 Å), sufficient to reduce enzymatic activities of native enzymes up to about 90 per cent, in general do not produce measurable amounts of smaller dialyzable fragments. The disappearance of the original boundary in sedimentation diagrams is mostly owing to the formation of rapidly sedimenting polydispersed material. Generally the sedimentation constants of the native proteins are not significantly changed. The boundaries, however, often lose their symmetry. The quantum yields for the disappearance of the original boundaries are roughly inversely proportional to the molecular weights. The number of molecules disappearing from the main peak is smaller than the number of molecules inactivated by a given dose. The data indicate that ultracentrifugation provides no satisfactory method for separation of native molecules from the damaged and inactivated. Proteins with labile quaternary structures (e.g., thyroglobulin or hemocyanine) that tend to dissociate under very mild conditions show an enhanced dissociation after uv-irradiation. (auth)

36162 NON-PROTEIN SULFHYDRYL CONTENT OF EHRLICH ASCITES TUMOR CELLS EXPOSED TO HYPERBARIC OXYGEN OR X-IRRADIATION. Harris, J. W. (Monash Univ., Clayton, Australia. Radiobiological Research Unit, Cancer Inst., Melbourne). Exp. Cell Res., 50: 293-305(May 1968).

The non-protein sulfhydryl (NPSH) content of Ehrlich ascites tumor cells (EAT) was depressed by hyperbaric oxygen, especially when the cells had been depleted of endogenous substrate by preincubation in air. No depression of NPSH was observed when the cells were suspended in medium supplemented with glucose or pyruvate; succinate and α-ketoglutarate did not prevent depression of NPSH. Depression of NPSH by oxygen also occurred with cultured wallaby fibroblasts, but not with rat thymocytes, rabbit exudate neutrophils, or rabbit bone marrow cells. A significant drop in the NPSH content of EAT could be achieved by oxygen exposures too brief to affect a number of other cell functions, and the level was restorable upon addition of appropriate substrates. X-irradiation (2000 rads) in oxygen did not affect the NPSH of Ehrlich ascites cells, although the oxygen itself exerted a depressing influence under certain conditions. Factors governing the rate and extent of NPSH depression by hyperbaric oxygen were discussed and the potential usefulness of the experimental findings in future investigations was emphasized. (auth)

36163 WHOLE-BODY RETENTION AND TISSUE DISTRIBUTION OF ^{134}Cs IN NEW-BORN, YOUNG AND ADULT RATS. Inaba, Jiro; Matsusaka, Naonori; Ichikawa, Ryushi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 8: 132-40(Sept.-Dec. 1967).

Comparative studies on the whole-body retention and distribution of ^{134}Cs were carried out for the rats of three different ages: new-born, young, and adult rats. All measurements were made by gamma counting with a liquid scintillation counter for small animals. The ^{134}Cs retention in young and adult rats might be approximated to exponential function associated with a few components, but in new born rats ^{134}Cs body burden decreased slowly in initial phase followed by a more rapid decrease. The ^{134}Cs distribution in young rats did not differ significantly from that in adult rats. A more detailed study on ^{134}Cs metabolism in new-born rats is in progress. (auth)

36164 COMPARATIVE STUDIES OF ^{132}Cs AND ^{86}Rb TURNOVER IN MAN USING A DOUBLE-TRACER METHOD. Iinuma, Takeshi (National Inst. of Radiological Sciences, Chiba, Japan); Watari, Kazuo; Nagai, Teruo; Iwashima, Kiyoshi; Yamagata, Noboru. J. Radiat. Res., 8: 100-15(Sept.-Dec. 1967).

Comparative studies of Cs and Rb metabolism were made with an adult male of human subject using ^{132}Cs and ^{86}Rb double-tracer method. Whole body retention and distribution after single oral administration were investigated by a whole body counter-scanner at the National Institute of Radiological Sciences, and total excreta in urine and feces that were collected for nine days after the administration were measured separately by the same detector. Marked differences were found in the biological half-lives, excretion patterns and distributions in the whole body between the two radionuclides. Whole body retention could be expressed by two-component exponential function of time for the both nuclides, but short-term component had a shorter half-life (1.0 day) for ^{132}Cs than that for ^{86}Rb (6.0 days) and long-term component had a longer-life (72 days) for ^{132}Cs than that for ^{86}Rb (53 days). Total excretion of ^{132}Cs for the first 5 days after the administration was correspondingly larger than that of ^{86}Rb, but fecal excretion of ^{86}Rb was slightly larger than that of ^{132}Cs which resulted in a large disagreement in values of urinary-to-fecal excretion ratio between the two. Whole body distributions obtained with the elapse of time since the administration indicated that ^{86}Rb was transferred to its final compartments within three days, but ^{132}Cs needed more than ten days. At the equilibrium in distribution ^{132}Cs concentrated in muscular tissues more specifically than did ^{86}Rb, but ^{86}Rb was more in liver, heart, and brain etc., than ^{132}Cs. These results suggest that Cs must have a different metabolic pathway from that of Rb, and that effective elimination of ^{137}Cs from the human body can be made by some means when applied before three days after accidental ^{137}Cs intake. (auth)

36165 UPTAKE OF ^{32}P BY YELLOW-FEVER MOSQUITO LARVAE OF EQUAL AGE, AND THOSE PUPATING SYNCHRONOUSLY: ITS LOSS AND TRANSFER DURING DEVELOPMENT, MATING, AND OVIPOSITION. Quraishi, M. Sayeed (North Dakota State Univ., Fargo). J. Econ. Entomol., 61: 530-3(Apr. 1968).

The resultant radioactivities of yellow-fever mosquito, Aedes aegypti (L.) adults, when instar III and IV larvae were treated with ^{32}P, have been studied. Instar III larvae incorporated comparatively greater amounts of radioactivity but also lost large amounts during development in distilled water. Instar IV larvae retained a considerable amount of the incorporated radioactivity during development under similar conditions. Synchronously pupating larvae yielded adults with comparatively less variation in radioactivity. There was little but measurable transfer of radioactivity from a radioactive male to a normal female during her first copulation. (auth)

36166 INFLUENCE OF INFECTIOUS VIRUS ON THE INDUCTION OF TRANSPLANTATION RESISTANCE IN THE FRIEND TUMOR SYSTEM. McCoy, J. L.; Fefer, A.; Glynn, J. P. (National Cancer Inst., Bethesda, Md.). Cancer Res., 27: 2267-71 (Dec. 1967).

Friend virus or Friend virus-induced tumors that shed Friend virus, immunized C57BL/6 mice against the transplantation of syngeneic Friend virus-induced tumors. To determine whether infectivity of the virus is essential for the induction of transplantation resistance, C57BL/6 mice were pretreated with Friend virus, formalin-inactivated Friend virus plus Freund's adjuvant, or with adjuvant alone. Only Friend virus induced resistance. Pretreatment with formalin-inactivated virus plus adjuvant re-

sulted in more tumor takes than in normal or adjuvant-treated controls. Specific antibody was detected by immunofluorescence and/or in vitro virus neutralization from mice pretreated with either Friend virus or formalin-inactivated Friend virus with or without adjuvant, but not adjuvant alone. Pretreatment with formalin-inactivated Friend tumor cells induced neither transplantation resistance nor formation of antibody. However, tumor cells exposed to formalin for only 3 hours shed Friend virus and induced transplantation resistance. The results suggest that with the usual immunization procedures, Friend virus, either directly or indirectly, is essential for the induction of transplantation resistance but not for the induction of antibody formation. (auth)

36167 FORMAL DISCUSSION: THE ROLE OF TRANSPLANTATION IN THE EXPERIMENTAL INVESTIGATION OF HUMAN LEUKEMIA AND LYMPHOMA. Adams, Richard A. (Children's Cancer Research Foundation, Boston). Cancer Res., 27: 2479-82(Dec. 1967).

Results are reported from studies on the transplantability of human leukemia cells in x-irradiated newborn hamsters. The histologic appearance, malignant potential, and clinical course of the disease are described. Two cell lines were used for transplantation. One was established by the administration of human malignant lymphoblasts previously established in continuous suspension culture from the peripheral blood of a child with acute lymphoblastic leukemia and the other was established by serial transplantation following administration to hamsters of peripheral blood buffy-coat cells from a patient with acute lymphoblastic leukemia. Progression of lymphosarcoma to leukemia was observed in hamsters following transplantation of both cell lines. (C.H.)

36168 INVESTIGATION OF THE EFFECT OF DATA ERROR IN THE ANALYSIS OF BIOLOGICAL TRACER DATA. Myhill, J. (Univ. of Sydney. Royal North Shore Hospital, Sydney). Biophys. J., 7: 903-11(Nov. 1967).

Data obtained from tracer studies often consist of serial measurements after administration of radioisotope. Very little work has been published on how the error in the data affects the mathematical analysis. Computer simulation was here employed to produce data with error of different magnitude and form for each of several values of rate constant and amplitude. The data were terminated when the value of the last point was 5% of the value of the first point, and also in other ways arranged to simulate experimental situations. The sets of simulated data for a two compartment system were analyzed by the gaussian iterative technique. With a rate constant ratio of at least four the technique converged for data errors of 5% or less. The calculated error in the rate constants ranged from 2 to 85%, and in the amplitudes from 1 to 50%, for data error of 0.5 to 10%. The lesser rate constant and amplitude had the greater errors. If a wrong assumption was made in the analysis about the variation of data error over the time interval of measurement, then the calculated values of parameter standard deviations were greatly in error. The results could be used to decide what experimental accuracy was needed for a given accuracy of model parameters for a variety of biological problems. (auth)

36169 TRACER DIFFUSION AND UNIDIRECTIONAL FLUXES. Curran, Peter F.; Taylor, Aubrey E.; Solomon, A. K. (Harvard Medical School, Boston). Biophys. J., 7: 879-901(Nov. 1967).

Available experimental data were utilized to examine the effects of cross-coefficients on tracer diffusion and on the estimation of unidirectional fluxes from observations on tracer flow. In free solution or in a nonselective membrane, the interaction between the flows of tracer and the unlabeled substance were small at concentrations of biological interest for the nonelectrolytes urea, alanine, and β-alanine, and for sodium and chloride ions. Under these conditions, measurement of tracer flow could be used to predict flow of the bulk substance to an accuracy of a few per cent. (auth)

36170 DEMONSTRATION OF GENETIC DISPARITY BY MIXED CULTURES OF ALLOGENEIC MOUSE LYMPH NODE CELLS. Tanaka, Sanae; Orita, Kunzo; Kaneda, Shoken (Okayama Univ., Japan). Transplantation, 6: 127-9(Jan. 1968).

It was demonstrated that in cultures of allogenic lymph node cells of mice, in the presence of phytohemagglutinin-M, there appeared to be an increased number of large and intermediate cells. Such large and intermediate lymph node cells were more common in the combination of Co-60 irradiated A plus normal C3H than in the reverse combination of irradiated C3H plus normal A. Also, the rate of transformation in the combination of (A × C3H)F_1 + C3H was higher than in the F_1 + A combination. This could be due to a stronger reaction of C3H lymph node cells against the numerous H-2^a antigens lacking in C3H (H-2^b). The strength of the reaction correlated well with the speed of rejection of skin grafts. (auth)

36171 A STUDY ON THE CLONAL NATURE OF SPLEEN COLONIES USING CHROMOSOME MARKERS. Chen, Michael G.; Schooley, John C. (Univ. of California, Berkeley). Transplantation, 6: 121-6(Jan. 1968).

Cytological evidence for the clonal origin of spleen colonies was presented. Karyotypic analysis of the spleen nodules produced by transplants of hematopoietic tissue from mouse radiation chimeras bearing three kinds of chromosome-marked cells showed 41 out of 48 spleen nodules to be composed entirely of one or another of the karyotypes. In the remaining seven nodules 92 to 98% of the dividing cells in each nodule were of the same type. Since no mixtures were observed in proportions consistent with other than single cell origin, the data lend further support to the clonal hypothesis of origin of the spleen colony. (auth)

36172 CYTOTOXIC TYPING ANTISERA FOR MARROW GRAFTING IN LITTERMATE DOGS. Epstein, R. B.; Storb, R.; Ragde, H.; Thomas, E. D. (Univ. of Washington, Seattle. Public Health Service Hospital, Seattle). Transplantation, 6: 45-58 (Jan. 1968).

Immunization of dogs with buffy coat cells from unrelated dogs consistently produced cytotoxic antisera that gave strong reactions but were too complex for suitable analysis. Cross immunization of littermate pairs produced cytotoxic antisera only infrequently, and these antisera gave weaker reactions. Four antisera were obtained by sibling immunization. They showed limited specificity as determined by cross absorption studies and typing of canine families. Genetic studies indicated that these antisera recognized independent antigens of dominant inheritance. Testing of lymphocytes from 62 unrelated dogs with these four antisera gave positive reactions with frequencies of 0.55, 0.53, 0.31, and 0.26. In order to evaluate the usefulness of these sera for histocompatibility typing, six litters were typed with the four antisera. A donor was selected from each litter, and an aliquot of marrow was infused into a matched and into a mismatched sibling following 1500 R of whole-body irradiation. None of the mismatched recipients lived longer than 14 days. All of the matched recipients lived beyond 40 days, and four of the six lived more than 100 days. It was concluded that cross immunization of litter mates produced reasonably specific typing sera. These sera were of value in selecting donor-recipient pairs of canine siblings for marrow grafting. (auth)

36173 HEMATOLOGICAL AND PATHOLOGICAL CHANGES INDUCED IN TOLERANT MICE BY THE INJECTION OF SYNGENEIC LYMPHOID CELLS. Cornelius, E. A.; Martinez, C.; Yunis, E. J.; Good, R. A. (Univ. of Minnesota, Minneapolis). Transplantation, 6: 33-44(Jan. 1968).

Strain A mice were rendered tolerant to (A × C57BL/1)F_1 hybrid tissue by means of a heavy dose of total body x irradiation and injection of hybrid spleen cells, in order to produce a chimera. These chimeras were then injected with spleen cells from strain A mice; this resulted in a runting syndrome that was characterized by weight loss, hematological depression, and depletion of lymphocytes in the lymphoid tissue. The hematological and pathological changes observed in these animals were similar to those in (A × C57BL/1)F_1 hybrid mice undergoing runting as a result of the injection of strain A spleen cells, except that the dermatitis and intestinal lesions regularly observed in classical runt disease did not occur in the wasting disease produced in syngenic mice. (auth)

36174 THYMUS-MEDIATED TOLERANCE TO CELLULAR ALLOANTIGENS. Vojtiskova, Marta; Lengerova, Alena (Inst. of Experimental Biology and Genetics, Prague). Transplantation, 6: 13-24(Jan. 1968).

The role of the thymus as a possible site of induction and maintenance of specific immune tolerance to cellular alloantigens was investigated. It was shown that sublethally irradiated mice could be made tolerant by an injection of H-3 incompatible spleen cells into or outside the thymus. When the inoculum was given extrathymically, dividing donor cells were found to penetrate into the thymus if the recipient was either newborn or sublethally irradiated when adult. A direct inoculation into the thymus would thus not be required for an intrathymic action of antigen in tolerance induction in the case of those cellular antigens that seem to possess a natural vehicle. In a second approach to the same problem, strain A mice were lethally irradiated and induced to recover by infusion of syngeneic fetal liver cells. The immature lyphoid cells from the curative inoculum were thymus-dependent and tolerance-responsive. Use was made of this situation by replacing the recipient's thymus by a syngeneic, but presumably CBA cell-containing thymus (from donors tolerant to CBA antigens) or by a semiallogeneic thymus (from (A × CBA)F_1 hybrids). In

both cases, the implanted thymus was the only source of CBA antigens for the induction of tolerance in the fetal cells. In the former case, where the tolerant thymuses were implanted subcutaneously to the radiation chimeras, only prolonged survival of CBA skin grafts resulted. The implantation of F_1 hybrid thymuses under the kidney capsule resulted in a high degree of permanent tolerance (i.e., lasting for more than 150 days). Transfer of hybrid lymph nodes to nonthymectomized but splenectomized chimeras resulted in only temporary tolerance while the effect of hybrid spleen was comparable to that of the thymus. A possible explanation of these findings based on a thymus-mediated mechanism of tolerance to cellular alloantigens was suggested. (auth)

36175 CHARACTERISTICS OF POPULATIONS OF THE SOMATIC CELLS OF IRRADIATED ANIMALS ACCORDING TO THE INTENSITY OF THEIR ULTRA-VIOLET FLUORESCENCE. Kondrat'eva, T. M. (Central Research Inst. of Roentgenology and Radiology, Leningrad). Tsitologiya, 9: 1559-64(Dec. 1967). (In Russian).

The distribution of cells of bone marrow and peripheral blood, Pliss lymphosarcoma cells, and lymphocytes according to the intensity of their ultraviolet fluorescence after irradiation with 500 R was studied. Non-irradiated cells were found to reveal a constant medium level of uv fluorescence, their distribution being according to the fluorescence intensity specific of every group. Irradiated cells and their progeny kept the character of this distribution unchanged, but the parameters of the latter were different. The mean value of uv fluorescence and the dispersion increased. A study has shown that the irradiation resulted in a appearance of homogeneous populations of cells with new features which persist during the whole period of the animal's life. Thus, a conclusion is made that these new characters may be hereditarily fixed and transferred to the progeny irrespective of the fact whether they had developed within the irradiated organism (cells of bone marrow and blood) or outside it (transplanted lymphosarcoma cells). (auth)

36176 STUDY OF THE RESPONSE OF SOMATIC CELLS TO IRRADIATION BY LUMINISCENT MICROSCOPY. Pinto, R. I. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1527-34(Dec. 1967). (In Russian).

A study was made of the immediate effects of ionizing radiation on somatic cells, using luminescence microscopy. Observation of solitary cells stained with acridine orange during the first hours after irradiation revealed structural breakages. Measurements of intensity and spectra of the fluorescence of cells and isolated nuclei were made and compared with those of DNA molecules and supermolecular structures. Ultraviolet fluorescence spectra of somatic cells showed radioinduced changes in proteins containing tryptophan. (H.L.W.)

36177 EFFECT OF IONISING IRRADIATION ON THE DNA OF LYMPHOSARCOMA CELLS. Pinto, R. I.; Shiryaeva, N. V.; Chupov, V. S. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1510-16(Dec. 1967). (In Russian).

Changes in supermolecular DNA structures obtained from the Pliss lymphosarcoma cells two hours after 500 R irradiation were studied. It was established that fluorescence spectra of acridine orange in complexes with cells, isolated nuclei, supermolecular DNA structures, and with native DNA practically coincided. The intensity of flourescence and of absorption of the complexes of AO with supermolecular structures of DNA obtained from irradiated cells is much higher than that in the control group (non-irradiated cells). Unlike irradiation, heat denaturation of supermolecular structures causes a reduction of the intensity of fluorescence and absorbance. Both irradiation and heat denaturation cause a diminishing of the reduced specific viscosity of the supermolecular DNA structures. The results obtained show that a 500 R irradiation causes conformative changes in macromolecules of supermolecular DNA structures. (auth)

36178 CELL RECOVERY SYSTEMS AND THE PROBLEM OF THEIR SENSITIVITY TO IRRADIATION DAMAGE. Paribok, V. P. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1449-59 (Dec. 1967). (In Russian).

The existence of recovery systems responsible for the elimination of irradiation damage of the cell was experimentally confirmed. A survey of experiments with yeast, plant, and animal (somatic and sexual) cells shows that data on the resistance of recovery systems of some objects are statistically reliable, whereas the evidence of their sensitivity to irradiation damage was not experimentally supported. For an experimental solution of the question some ways may be suggested: a study of the kinetics of elimination of radiation damage at different doses and an irradiation of the reparation systems spatially removed from structures to be recovered. (auth)

36179 LABELING LARVAE OF THE ELM SAWFLY WITH ^{32}P. Stein, John D. (Rocky Mountain Forest and Range Experiment Station, Bottineau, N. Dak.). J. Econ. Entomol., 61: 508-10(Apr. 1968).

Fourth-instar larvae of the elm sawfly, Cimbex americana americana Leach, were successfully tagged by ingesting radioactive foliage. The systemic property of ^{32}P was used by injections of a 3-microcurie solution into a cotton band placed around a white willow, Salix alba L, branch. Translocation of the isotope solution into the leaves provided enough radioactive food substance to effectively locate the tagged larvae with a portable Geiger–Müller counter. A "true" larval assimilation index was established by taking the difference between the counts per minute for the larvae and for the ejected frass. Irregularity in this computed index was explained by a combination of factors involving the cessation of feeding and excretion of an abnormally high amount of frass from the digestive tract. (auth)

36180 EFFECT OF PHAGOCYTOSIS AND X-IRRADIATION ON HUMAN LEUKOCYTE METABOLISM. Selvaraj, Ratnam J.; McRipley, Ronald J.; Sbarra, Anthony J. (St. Margaret's Hospital, Boston. Tufts Univ., Boston). Cancer Res., 27: 2280-6 (Dec. 1967).

The metabolic activities of human leukocytes during phagocytosis were studied to establish the the respiratory activity, glucose-1-^{14}C and glucose-6-^{14}C oxidation, and lactate production by human leukocytes in the absence and presence of different particulate material. It was noted that with phagocytizing cells, increases in all of the parameters studied were evident. The effect of x irradiation on these parameters was also investigated. Leukocytes isolated from patients undergoing x ray therapy also showed a stimulation in the parameters measured when they were phagocytizing. However, the increases were not as great as with leukocytes isolated from patients not receiving x ray therapy. X irradiation of leukocytes in vitro resulted in no demonstrable changes in any of the metabolic parameters studied. (auth)

36181 THE ORIGIN OF TAURINE EXCRETED IN THE URINE OF RATS AFTER IRRADIATION WITH $^{60}Co\gamma$. CONCLUSIONS. Boquet, P. L.; Fromageot, P. (Commissariat a l'Energie Atomique, Gif-sur-Yvette, France). Int. J. Radiat. Biol., 13: 343-53 (1967). (In French).

The distribution of injected ^{35}S-taurine in the tissues of rats was used to determine the origin of excess taurine excreted in the urine following exposure to doses of 600 to 700 R γ radiation. Taurine was found to be present in a pre-existing pool in rapid exchange with plasma. The excess taurine excreted in urine during 24 to 36 hr following irradiation was found to originate in the spleen, intestinal mucosa, and lymphoid tissues. The active transport system of taurine in the muscles was not affected by irradiation. Mitomycin induced excess excretion of taurine similar to that caused by irradiation. Cysteamine injected before irradiation prevented the excretion of excess taurine. (C.H.)

36182 EFFECT OF ULTRAVIOLET IRRADIATION ON THE SULFHYDRYL CONTENT OF MOUSE MELANOMA. Ogura, Ryohei; Takeoka, Ariaki; Seiji, Makoto; Sakurane, Takatoshi; Itakura, Hideko (Univ., Kurume, Japan). J. Invest. Dermatol., 50: 367-70(June 1966).

The effects of ultraviolet light irradiation on soluble and protein-bounds sulfhydryl groups of mitochondria, melanosomes, and supernatant fractions isolated from B-16 and Harding–Passey mouse melanomas were studied. Both protein-bound SH and sulfosalicylic acid-soluble SH in melanosomes isolated from tumors were found to be unaffected by uv exposure. A protective effect of melanin against uv was deduced. Protein-bound SH and sulfosalicylic acid-soluble SH in the supernatant fraction and mitochondria fraction were found to be decreased by ultraviolet exposure. (auth)

36183 HISTOCHEMICAL STUDY OF IONIZING RADIATION EFFECTS ON NERVE CELLS IN NEUROPLEXUS DIGESTIVE TRACT. Tkachenko, Z. Ya. Fiziol. Zh., Akad. Nauk Ukr. RSR, 13: 841-4(1967). (In Russian).

The effects of ionizing radiations on the metabolism of nucleic acids in the central and peripheral nervous system are reviewed. Results are reported from studies on radiation effects on the DNA and RNA synthesis by the nerve cells of the neuroplexus of the digestive tract of 26 rabbits that were whole-body x-irradiated at a dose of 800 R. (R.V.J.)

36184 THE INVESTIGATION OF THE ACTIVITY OF SOME DEHYDROGENASES IN INFUSORIA AFTER X-IRRADIATION. Kovaleva, N. E.; Frenkel, M. A. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1550-8(Dec. 1967). (In Russian).

The activity of some dehydrogenases in irradiated Paramecium caudatum was investigated. The dose of 75 kR caused changes in

metabolic processes of ciliates. During the first (3 to 4) post-irradiation days the enzyme activity of the Embden–Meyerhoff mechanism for glycolysis (lactic and α-glycerophosphate dehydrogenases) was relatively high, and the amount of lactic acid significantly increased in comparison with non-irradiated ciliates. These facts presented evidence of inhibition of the Pasteur effect. Whereas activity of lactic and α-glycerophosphate dehydrogenases had returned to a normal level by the 20th day after irradiation, the amount of lactic acid, by the same time, fell below the rate of control cells. Succinate and glucose-6-phosphate dehydrogenase activities in irradiated ciliates decreased during the first 3 to 4 days following the irradiation. From the 10th to the 20th day after irradiation the ciliates showed a high activity of these enzymes as compared with non-irradiated cells. Thus, the alteration in the enzymes studied suggests the two general periods in the metabolism of the irradiated infusoria: the increasing of aerobic glycolysis and the increasing of oxidative processes. (auth)

36185 MODIFICATION OF X-RAY-INDUCED KILLING OF HeLa S3 CELLS BY INHIBITORS OF DNA SYNTHESIS. Weiss, Barbara G.; Tolmach, L. J. (Mallinckrodt Inst. of Radiology, St. Louis. Washington Univ., St. Louis). Biophys. J., 7: 779-95(Nov. 1967).

After irradiation of HeLa S3 cells with 220 kV x rays during G1, treatment with any of six inhibitors of DNA synthesis resulted in the progressive enhancement of cell killing (loss of colony-forming ability). Incubation with hydroxyurea, cytosine arabinoside, or hydroxylamine reduced survival five- to twentyfold in about 8 hr, following an x-ray dose of 400 rads. In contrast, treatment with 5-fluorodeoxyuridine, deoxyadenosine, or thymidine after this same dose reduced survival less than twofold during a comparable time interval. These differences occurred at drug concentrations which reduced the rate of DNA synthesis by at least 95% (except in the case of hydroxylamine, which inhibited DNA synthesis to a smaller extent), but which killed no unirradiated cells during the treatment periods. When inhibition of DNA synthesis with either hydroxyurea or cytosine arabinoside was reversed by addition of appropriate precursors of DNA, the enhancement was abolished. With hydroxyurea, the rate of cell killing was dependent on the dose of x rays previously administered, and the extent of enhancement seemed to be related to the drug concentration. Imposition of a delay between irradiation and addition of hydroxyurea did not abolish the enhancement effect, but instead caused a proportional lag in its inception. Postirradiation treatment of S phase cells with either hydroxyurea or cytosine arabinoside also enhanced killing. Furthermore, unlike early G1 cells, S cells (and, as shown previously, cells blocked at the G1-S transition) were sensitized by preirradiation exposure to hydroxyurea. (auth)

36186 RECOVERY OF THE HEMOLYSIN RESPONSE IN MOUSE RADIATION CHIMERAS. Agarossi, Giovanna; Doria, Gino (CNEN-EURATOM, Rome). Transplantation, 6: 419-26 (May 1968).

Recovery of the immune system of mouse radiation chimeras immunized with sheep red blood cells was estimated by enumeration of hemolysin-forming spleen cells and titration of serum hemolytic activity. Both estimates were found to attain normal values in isogenic chimeras. In allogenic chimeras the recovery of the hemolysin titer remained subnormal during the 5 months of observations, and it was attributed to insufficient number of hemolysin-forming cells in the spleen. The correlation between numbers of hemolysin-forming spleen cells and hemolysin titer was introduced as a new criterion to evaluate the recovery of the immune system of mouse radiation chimeras. (auth)

36187 γ IRRADIATION OF DEOXYRIBONUCLEIC ACID IN DILUTE SOLUTIONS. I. A SENSITIVE METHOD FOR DETECTION OF SINGLE-STRAND BREAKS IN POLYDISPERSE DNA SAMPLES. Summers, William C.; Szybalski, Waclaw (Univ. of Wisconsin, Madison). J. Mol. Biol., 26: 107-23(1967).

To study radioinduced single-strand (SS) breaks in bacterial DNA irradiated in dilute solution in vitro, a new technique was developed to overcome the polydispersity that makes interpretation of sedimentation velocity techniques difficult. Irradiation (with ^{137}Cs) was carried out on DNA of various base compositions extracted from Sarcina lutea (71% G + C); Escherichia coli B and 15 T⁻ (50% G + C); Bacillus subtilis W23 (43% G + C), and Cytophaga johnsonii (34% G + C). The method used for determining the rate of production of SS scissions in polydisperse populations of DNA molecules was based on determination of the progressive loss of the rapid renaturability (zippering-up) of cross-linked DNA. It was used to assay strand breakage induced by irradiation or by DNAase I. Radiosensitivity to SS scission was proportional to the molecular size but independent of the average base composition or substitution of bromouracil for thymine. The radioprotective effects of cysteine, cysteamine, and self-protection high DNA concentrations were demonstrated. (BBB)

36188 CELL DIVISION DURING INHIBITION OF DEOXYRIBONUCLEIC ACID SYNTHESIS IN ESCHERICHIA COLI. Helmstetter, Charles E.; Pierucci, Olga (Roswell Park Memorial Inst., Buffalo. State Univ. of New York, Buffalo). J. Bacteriol., 95: 1627-33(May 1968).

When cultures of Escherichia coli B/r growing at various rates were exposed to ultraviolet light, mitomycin C, or nalidixic acid, deoxyribonucleic acid (DNA) synthesis stopped, but cell division continued for at least 20 min. The chromosome configurations in the cells that divided were estimated by determining the rate of DNA synthesis during the division cycle. The cultures were pulse-labeled with ^{14}C-thymidine, and the amount of label incorporated into cells of different ages was found by measuring the radioactivity in cells born subsequent to the labeling period. The cells that divided in the absence of DNA synthesis were those that had completed a round of chromosome replication prior to the treatments. It was concluded that completion of a round of replication is a necessary and sufficient condition of DNA synthesis for cell division. (auth)

36189 EFFECT OF SMALLPOX VACCINATION ON LEUKEMOGENESIS IN MICE: DISCUSSION OF A POSSIBLE COCARCINOGENIC ACTIVITY OF ECTROMELIA VIRUS. Mouriquand, J.; Mouriquand, C.; de Robien, E.; de Choudens, H. (CEN, Grenoble, France). Ann. Inst. Pasteur, 111: 257-64(Sept. 1966). (In French).

Radioinduced leukemia developed five weeks (on the average) after irradiation of PS strain mice; it appeared as generalized reticulosarcoma that was accompanied by areas of splenic necrosis. A transmissible viral agent of the smallpox type was isolated. Fifteen days after smallpox vaccination, 47 PS mice were x irradiated with 280 RAD in four doses of 70 RAD each and at weekly intervals; 38 nonvaccinated PS females were irradiated in the same way. The incidence of leukemia in the vaccinated group was 12.7% at the mean age of 9.2 months and 39.4% at the mean age of 7.5 months in the nonvaccinated group. The part played by the ectromelia virus, latent in the PS mice strain, was discussed; its possible cocarcinogenic activity through a depletive action on thymus was suggested. (BBB)

36190 QUANTITY DIPPING AND PROCESSING OF RADIOAUTOGRAPHIC SLIDES. Jerry, Norman L. (Canada Dept. of Agriculture, London, Ont.). J. Biol. Photogr. Ass., 35: 73-82 (May 1967).

A system is described for coating and processing numerous radioautographic slides at one time. The coating procedure includes dipping, drying, and storing for exposure; the processing procedure includes processing, washing, and drying. Sufficient equipment and materials were used to dip and process 120 1 × 3 in. slides. Quantities are given for materials as a guide for a run of 120 slides. The use of heat-retaining, light-resistant holding breakers and of the modified boxes for oven-drying is described. There was no fogging, reticulation, curtaining, or slipping of the emulsion. The emulsion thickness with a single dipping averaged 2 μ. (BBB)

36191 THYROXINE CONTENT IN THYROID GLANDS OF DOMESTIC ANIMALS. PART I. A RADIOACTIVE METHOD FOR DETERMINATION OF THYROXINE. Abdel-Wahab, M. F.; Hussein, M. Abdel-Moneim (Middle Eastern Regional Radioisotope Centre for Arab Countries, Dokki, Cairo). Endokrinologie, 52: 102-9(1967).

A radioisotope method was developed as a new analytical procedure for the preparation and determination of thyroxine from the thyroid gland, and it was tested on the thyroids of camel, cow, buffalo, and sheep. Isolation of thyroxine from the thyroids of these domestic animals in pure form was achieved by the use of a gel-filtration method. Comparative determination of thyroxine in the thyroid glands of the four domestic animals revealed that camel thyroid contains more thyroxine than the thyroid of the other animals investigated. The thyroid of sheep has the least amount of the thyroid hormone. Evaluation of the hormone content was based on the measurements of the maximum radioactivity of the labeled hormone and its maximum absorption in the uv region of the spectrum. (BBB)

36192 ACTIVATION ANALYSIS ON MAN: A NEW TOOL FOR MEDICAL RESEARCH? Sci. Res., 2: 53-6(July 1967).

The use of activation analysis for medical studies on man is described. In one study, only the thyroid gland is exposed for 5 min to a reactor-generated thermal neutron flux of about 2×10^7 n/cm²/sec, after which the induced ^{128}I in the gland is counted by a NaI detector. The iodine content of the thyroid is calculated by comparing the area under the ^{128}I 0.46-MeV photopeak with that of

an iodine standard irradiated and counted under similar conditions. In a second study, whole-body measurements of chloride, Ca, and Na were made on patients following exposure to a beam of partially moderated 14-MeV neutrons from a Cockcroft–Walton generator. Human cadavers and phantoms were exposed for 10 to 15 sec to a cyclotron-produced low-level fast-neutron flux at a whole-body dose of 1 Rem or less; the whole-body Ca content was then determined by counting the induced ^{49}Ca by an array of NaI crystals. Measurements of the radiation dose absorbed during irradiation of the patients in the clinical studies showed that the total absorbed dose was no greater than that from clinically acceptable diagnostic procedures using radioisotopes. (C.H.)

36193 TRANSFER OF ^{85}Sr THROUGH PLACENTA AND MOTHER'S MILK. I. Matsusaka, Naonori; Ikeda, Miyoshi (Tokyo Univ.). Nippon Juigaku Zasshi, 28: 315-20(Dec. 1966).

The transfer of ^{85}Sr from mother to offspring through the placenta during intrauterine life and through mother's milk during nursing was observed in experimental mice. Three groups of female mice were injected intraperitoneally with 2 μCi of ^{85}Sr in 0.5 ml saline solution as a single tracer dose and mated at different intervals after injection. The amounts of ^{85}Sr accumulated in the young at birth were 0.087, 0.067, and 0.047% of the dose in those derived from mice mated 1 to 2 weeks, 2 to 3 weeks, and 4 to 5 weeks after ^{85}Sr injection, respectively. From these results, it was apparent that the shorter the interval between injection and parturition, the greater became the ^{85}Sr content in the young at birth. In the young brought forth by a ^{85}Sr-contaminated mother and nursed with her breast milk, the accumulation of ^{85}Sr increased rapidly on the 3rd day after birth. The ^{85}Sr retained by the suckling was derived partially from placental transfer and partially from mother's milk. The relative contributions by the transplacental and milk-borne ^{85}Sr taken by the suckling during the nursing period were calculated. The contribution of transplacental ^{85}Sr decreased rapidly after birth. On the contrary, that of milk-borne ^{85}Sr increased during nursing. (auth)

36194 TRANSFER OF RADIATION ENERGY BETWEEN DIFFERENT SOLUTES IN FROZEN AQUEOUS SOLUTIONS. Sanner, Tore; Henriksen, Thormod; Pihl, Alexander (Norwegian Radium Hospital, Montebello, Oslo). Radiat. Res., 32: 463-74(1967).

Electron spin resonance studies were carried out on frozen aqueous mixtures containing a macromolecule (Sephadex or Thiogel) and the thiol, penicillamine. The samples were irradiated in vacuum with x rays at 77°K, and the measurements were carried out immediately after irradiation and after subsequent heat treatments. All electron spin resonance measurements were carried out at 77°K. Before heat treatment the radical yields were only slightly higher than expected on the basis of the composition of the mixtures. However, after heat treatment to 223°K the observed number of unpaired spins remaining in the mixture was much greater than expected. Decomposition of the spectra demonstrated that the excess radicals were localized on penicillamine. For low concentrations of penicillamine the number of penicillamine radicals in the mixture was twelve to seventeen times as great as that found when a pure penicillamine solution was studied. However, when the penicillamine concentration exceeded a certain value, the efficiency of the transfer of unpaired spins to penicillamine decreased. The results showed that in frozen aqueous mixtures of macromolecules and a thiol an appreciable transfer of unpaired spins could occur from the macromolecule to the thiol. The data indicate that this transfer occurs mainly from a limited number of sites on the macromolecules. (auth)

36195 AN ELECTRON MICROSCOPIC STUDY OF THE EFFECTS OF X-RADIATION ON THE MOUSE THYMUS. Fujisaki, Shigeru (Niigata Univ., Japan). Acta Med. Biol. (Niigata), 14: No. 3, 115-30(Dec. 1966).

The sequential changes occurring in the thymus of young C57BL mice after whole-body x irradiation with a dose of 200 R were examined with the electron microscope. The ultrastructural changes in the thymus after irradiation were subdivided into three stages: the prenecrotic, necrotic, and recovery. At the prenecrotic stage, mitochondrial and nuclear changes in some thymocytes were observed. The necrotic changes in the thymocytes and phagocytosis of necrotic cells by macrophages were first observed at 2 or 3 hours after irradiation. The necrotic and further decomposed thymocytes seemed to be rapidly ingested by macrophages. The most extensive destructions were demonstrated at 6 and 12 hours after irradiation. The cytoplasm of macrophages contained various stages of degradation of phagocytized thymocytes. Necrotic changes were still present at 24 hours after irradiation. This involved thymocytes in the cortex and medulla. The recovery process in the thymus was already seen at 48 hours after irradiation. The cellular debris in the cytoplasm of macrophages became smaller and appeared to be represented by small granules. After 72 hours following irradiation, macrophages seemed to be gradually decreased in number and were often found in the vicinity of the vessels. At 168 hours after irradiation, most of the macrophages disappeared and their cytoplasm contained only a small amount of granules and vacuoles. In comparison with the epithelial and reticulum cells, the thymocytes were found to be more sensitive to x irradiation. (NSA of Japan)

36196 CHANGE OF THE ULTRASTRUCTURE OF ORAL CAVITY CANCER DUE TO RADIUM IRRADIATION. Yotsumoto, Mitsugu (Kagoshima Univ. [Japan]). Kokobyogakkai Zasshi, 15: 511-27(Oct. 1966). (In Japanese).

The ultrastructure of cancer tissues before and after radium γ irradiation (8000 R) was studied electron microscopically in 13 cases, including upper-jaw cancer, lower-jaw cancer, buccal cancer, and one case of lower-lip cancer. In the cancer tissue, a slight degeneration was observed immediately after irradiation and a severe necrosis occurred after 10 and 20 days. Cells, resembling the young cells before irradiation, appeared after 30 days. Nuclei were seriously degenerated at the 20th day after irradiation, and they became normal after 30 days, although many were small. The destruction of the nuclear membrane was scarcely observed. The nucleolus either swelled or changed in its internal structure after 10 to 20 days. Mitochondria showed degenerative changes such as shrinkage and swelling from immediately to 20 days after irradiation, but these were restored to the preirradiative state by the 30th day. In Golgi's apparatus, the shrinkage of Golgi's field was observed after irradiation. A marked vacuolization of smooth surfaced endoplasmic reticulum (SER) was observed after 10 days, but after 30 days many SER with bright contents appeared. Ribosomes decreased gradually until the 20th day after irradiation but increased after 30 days. The tonofilament decreased after 20 days and recovered after 30 days. A large number of lysosomes was found at the 20th day when the destruction of cancer tissue was severest. (NSA of Japan)

36197 CHANGES IN METABOLIC PROCESSES IN LEUKOCYTES IN HUMANS EXPOSED TO SUPER-HIGH-FREQUENCY FIELD AND INFRARED IRRADIATION OF WEAK INTENSITIES. Zakharov, I. V. (Lab. of Electronics, Minsk). Dokl. Akad. Nauk BSSR, 11: 1113-16(Dec. 1967). (In Russian).

A single whole-body irradiation with weak high-frequency radio waves (1 to 5 $\mu W/cm^2$) increased the activity of peroxidase and glucogenesis in leukocytes of the peripheral blood for 3 to 7 hr after exposure. Irradiation with weak doses of infrared rays did not induce any changes in leukocyte metabolism. An increase of infrared doses to 4000 $\mu W/cm^2$ induced changes in the metabolism of leukocytes identical to those observed in humans exposed to radio wave radiation. However, this effect disappeared within an hour after the exposure. The changes in metabolism during whole-body exposure were not observed during irradiation of blood preparations and obviously are of functional character. (R.V.J.)

36198 LIPID CHANGES IN DIFFERENT RAT ORGANS AFTER WHOLE-BODY IRRADIATION WITH LETHAL X-RAY DOSES. V. THE BEHAVIOR OF THE LIVER FAT FRACTION. Eberhagen, Dietrich; Roeder, K. (Univ., Munich). Strahlentherapie, 135: 254-6(Feb. 1968). (In German).

After lethal whole-body irradiation, the neutral fat fraction in the liver of rats was markedly reduced; this decrease to one-fourth the original value lasted six hours. Consequently, fat was again stored in the liver; on the second day after irradiation half the original value was reached. Finally, an almost complete loss of fat occurred again. The amount of free cholesterol changed only transiently; the cholesterol-esters however fell immediately after irradiation without further modification. (auth)

36199 THE AVERAGE ENERGY REQUIRED TO PRODUCE AN ION PAIR IN ARGON, NITROGEN, AND AIR FOR 1- TO 5-MeV ALPHA PARTICLES. Chappell, S. E.; Sparrow, J. H. (National Bureau of Standards, Washington, D. C.). Radiat. Res., 32: 383-403(1967).

The absolute value of W, the average energy required to produce an ion pair, was measured in argon, nitrogen, and air for alpha particles with initial energies between 1 and 5 MeV. Six alpha-particle sources having different energies were fabricated by placing various thicknesses of Mylar film over a collimated ^{210}Po (5.3-MeV) alpha-particle source. For each source the total ionization produced in each gas by a determined number of alpha particles was measured in a parallel-plate ionization chamber. Then the mean energy of each source was evaluated by using a time-of-flight apparatus. From these combined results, W was calculated. It was constant within experimental error for argon, but it exhibited a change in value of approximately 1% for nitrogen and air over the specified energy range. These results for nitrogen and air disagree with the energy dependence for W found by other investigators. (auth)

36200 CHEMISTRY OF THE HYDRATED ELECTRON IN OXYGEN-FREE SOLUTIONS OF AMINO ACIDS, PEPTIDES, AND RELATED COMPOUNDS. Willix, Rodney L. S.; Garrison, Warren M. (Univ. of California, Berkeley). Radiat. Res., 32: 452-62(1967).

In extending previous studies on the radiation-induced deamination of the simpler α-amino acids in oxygen-free solution, it was found that reductive deamination by the hydrated electron, e^-_{aq}, is not confined to the free amino acid configuration. The dipeptides, tripeptides, and other derivatives of glycine, for example, are found to react with e^-_{aq} (essentially quantitatively) to cleave the N–C bond of the primary amino group. Radiolysis studies of variously substituted amino compounds in solutions containing second solutes that are specific scavengers of H, OH in the one case and of e^-_{aq} in the other indicated that reductive deamination by e^-_{aq} required an unsaturated function at the carbon position α to the amino group. It was suggested that e^-_{aq} adds to this function and that N–C cleavage then ensues. Observed correlations between rates of reaction of e^-_{aq} and pK of the amino group were in accord with this formulation. Velocity constants for reaction of e^-_{aq} with amino acids and derivatives in both acidic and neutral solution were obtained by the method of competition kinetics. (auth)

36201 DISTRIBUTION OF SUBSTANCE P IN THE CENTRAL NERVOUS SYSTEM AND SMALL INTESTINE OF THE RAT AFTER X IRRADIATION. Christensen, H. Dix; Haley, Thomas J. (Univ. of California, Los Angeles). Radiat. Res., 33: 588-95(1968).

The effects of 600 R of whole-body x irradiation on the levels of substance P in the central nervous system and small intestine of the rat were investigated. Concentrations in the cortex, brain stem, spinal cord, duodenum, jejunum, and ileum were measured at 1, 6, 24, and 72 hours and at nine months postirradiation. Significant changes occurred in concentrations as follows: an increase in spinal cord at six hours, and in the cortex, brain stem, and spinal cord at 24 hours; and a decrease in the brain stem, duodenum, and jejunum at nine months. Levels were measured at 24 hours and at nine months after partial-body irradiation, to ascertain whether the effects were direct or abscopal. Alterations were not conclusive. No changes occurred in the normal distribution with age. (auth)

36202 NON-S-PHASE INCORPORATION OF ^{3}H-THYMIDINE INTO DNA OF X-IRRADIATED MAMMALIAN CELLS. Hill, M. (Inst. of Biophysics, Brno). Int. J. Radiat. Biol., 13: 199-203 (1967).

L strain cells were seeded into Petri dishes with cover-slips on the bottom. After 24 hours, the cell cultures were exposed (at room temperature) to x irradiation at a rate of 200 R/min and ^{3}H-thymidine was applied at a concentration of 10μCi/ml either just before, or at various intervals after, irradiation. The labelling period was as long as 45 min, since exposures required times of up to 40 min. In control experiments, sham-irradiated cells showed no differences in labelling patterns in spite of being maintained for periods up to 40 min at room temperature. Fixation of cells, washing, DNase treatment, and autoradiographic procedure were carried out. The autoradiograms were exposed for 14 days before examination. No labelling was encountered after DNase digestion of parallel preparations. The cell populations were divided into two classes of cells according to the possibility of counting single grains over the nuclei. The heavily labelled cells were those in the S-phase at the time of labelling. Their proportion was not significantly influenced by various x ray exposures. The other cells were either unlabelled or lightly labelled and, for the sake of simplicity, were regarded as non-S-phase cells. Another experiment was performed to follow the rate of DNA labelling in non-S phase cells after irradiation. Cell cultures were exposed to 8000 R and pulse-labelled with ^{3}H-thymidine either during irradiation or at various intervals after irradiation. The peak of labeling was reached soon after x ray exposure. Subsequently, the amount of label per average non-S-phase cell declined very slowly. A significant incorporation of label into DNA was detected as late as 5 hours after irradiation. Results indicate that x irradiation induces the incorporation of ^{3}H-thymidine into DNA of G_1 and G_2 cells. The labeling in the G_2 phase was substantiated by the incidence of lightly labelled mitoses. (C.H.)

36203 COMPENSATORY REACTIONS IN INTESTINAL CRYPT CELLS AFTER 300 ROENTGENS OF ^{60}Co GAMMA IRRADIATION. Lesher, S. (Argonne National Lab., Ill.). Radiat. Res., 32: 510-19(1967).

A single 300-R whole-body ^{60}Co γ-ray dose markedly changed the proliferative cells in the mouse duodenal crypts. Cells in all phases of the generation cycle were affected as follows: Most cells in mitosis completed division, but the process was prolonged; cells in G_2 were blocked in G_2 for approximately 4¼ hours and then experienced difficulty with mitosis; cells in S continued DNA synthesis, but at a reduced rate; however, after synthesis was completed they appeared to move through G_2 and divide; and movement of G_1 cells to S was retarded. During the recovery phase, when killed and less-damaged cells were being replaced, the repopulation of the crypts and the return to the normal steady-state relationship that existed between the proliferative and non-proliferative cells of the intestinal epithelium were hastened by two compensatory mechanisms: an acceleration of the generation cycle and an increase in the number of cells in the proliferative compartment. (auth)

36204 IN VIVO STUDIES ON THE INTERACTIONS OF Pu(IV) WITH BLOOD CONSTITUENTS. Stevens, W.; Bruenger, F. W.; Stover, Betsy J. (Univ. of Utah, Salt Lake City). Radiat. Res., 33: 490-500(1968).

The distribution of ^{239}Pu in blood plasma of beagles was determined as a function of time after injection of ^{239}Pu in a citrate buffer solution. The plasma was subjected to gel filtration. Significant amounts of ^{239}Pu were found in the region of low-molecular-weight proteins and in the molecular weight range of small molecules or ions. The amount of ^{239}Pu bound to protein increased during the first few hours after injection, reached a maximum at about seven hours, and then decreased steadily. Concomitantly the ^{239}Pu found in the region of low-molecular-weight compounds decreased continuously from five minutes to 30 days. The decrease in the amount of ^{239}Pu in the region of low-molecular-weight compounds occurred more rapidly than did the decrease in ^{239}Pu associated with low-molecular-weight proteins. The proteins that bound ^{239}Pu were identified as transferrin and albumin. These protein-^{239}Pu complexes were separated by ion-exchange chromatography. Their identity was confirmed by electrophoresis and by ^{59}Fe labeling. The amount of ^{239}Pu bound by transferrin greatly exceeded the amount bound by albumin. (auth)

36205 PRIMARY RADICAL YIELDS IN PULSE-IRRADIATED ALKALINE AQUEOUS SOLUTION. Fielden, E. M.; Hart, Edwin J. (Argonne National Lab., Ill.). Radiat. Res., 32: 564-80 (1967).

Relative primary radical yields of hydrated electrons, H atoms, and OH radicals were determined by measuring the amount of hydrated electron formed following a single 4-μsec pulse of x rays. In neutral solution the amount of hydrated electron produced corresponded to $G(e^-_{aq})$, and at high pH's an additional amount was formed corresponding to G(H) by the reaction $H + OH^- = H_2O + e^-_{aq}$. In the presence of dissolved hydrogen the OH radical in yield G(OH) was also converted to hydrated electrons by reaction with hydrogen. The high optical absorption of the hydrated electron at 7000 A was used as a measure of its concentration. A pH range from 7 to 14.5 was covered. At pH above 12 the total radical yield, $G(e^-_{aq}) + G(H) + G(OH)$, was constant, as is the total reducing yield, $G(e^-_{aq}) + G(H)$. These relative yields were placed on an absolute basis by measuring the manganate ion yield in a formate–permanganate solution. The value of $G(e^-_{aq})$ was 2.7 in neutral and 3.1 in strong alkaline solutions. The primary radical yields $g(e^-_{aq})$, g(H), and g(OH), computed from diffusion theory, were 3.04, 0.53, and 2.81 at pH 13, respectively, and $g(e^-_{aq}) = 2.65$ at pH 7. The mechanism of the pH effect was briefly discussed. (auth)

36206 THE EFFECT OF IRRADIATION AND INFUSION OF MARROW, AND SPLEEN CELLS ON AUTOIMMUNE ANEMIA IN NZB/Bl MICE. Lindsey, E. S.; Woodruff, M. F. A. (Univ. of Edinburgh). Proc. Roy. Soc. Med., 60: 826(Aug. 1967).

Survival of erythrocytes transfused to NZB/Bl mice from isogenic donors did not differ significantly from that of the recipient's own erythrocytes, irrespective of whether or not the donor (or the recipient) was Coombs positive or showed evidence of abnormal erythrocyte destruction. This indicated that the anemia that developed in these mice was due to disordered function of the animal's immunological apparatus and not to an abnormality in its erythrocytes. Adult Coombs-positive NZB/Bl mice were heavily irradiated and then re-equipped with lymphoid cells from either a young Coombs-negative NZB/Bl mouse or a mouse of some other strain. Whether mice treated in this way became Coombs negative was investigated. The mice were exposed to 800-R whole-body irradiation and then given an intravenous injection of bone marrow and spleen cells or bone marrow alone, from either young Coombs-negative NZB/Bl mice or Coombs-negative (NZB/Bl X CBA/T6 F_1) hybrids. Conversion to Coombs negativity occurred significantly earlier in the mice that received F_1 cells. Thus two months after treatment the Coombs test was negative in six out of six F_1 cell recipients, as compared with four out of 12 isogenic cell recipients. Chromosome studies were carried out on the longest survivor in this group and it was found that all the dividing cells in the spleen and lymph nodes,

and 90% of the dividing cells in the bone marrow, were of donor origin. (BBB)

36207 EFFECTS OF CONTINUOUS IRRADIATION OF MICE ON THE IMMUNE RESPONSE TO LIVE LISTERIA MONOCYTOGENES. Stewart, Ronald H.; Hodge, F. A.; Silverman, Myron S. (Naval Radiological Defense Lab., San Francisco). J. Infect. Dis., 117: 109-15(Apr. 1967).

LAF_1 mice exposed continuously to ^{60}Co γ radiation delivered at 1 to 1.5 rad/hr were exposed to a midlethal dose of a live avirulent strain of L. monocytogenes immediately after accumulation of either 1700 to 2200 rad or 2800 to 3000 rad. The surviving mice were challenged two weeks later with a second aerosol that contained the organism to determine their immune state. All nonirradiated mice exposed to the two aerosol-transmitted infections survived, whereas 24% of the 1700- to 2200-rad irradiated mice and 54% of the animals receiving 2800- to 3000-rad succumbed to the second infection. If the irradiated mice were immunized with two aerosol exposures at a two-week interval, both the irradiated (2200 rad) and the nonirradiated animals survived. Immunity following a single exposure was of short duration. If the challenge was postponed until four weeks after the immunizing exposure, 90% of the irradiated mice died. Clearance of L. monocytogenes from lungs, liver, and spleen was rapid in the nonirradiated immune group. By the fourth day after challenge few organisms could be isolated. If the mice were irradiated prior to immunization, clearance was delayed. Bacteria could still be found in all organs four days after infection. Large numbers of bacteria could be isolated from both groups of nonimmune mice. (BBB)

36208 EFFECT OF ^{131}I ON THYROID AND PITUITARY OF THE GOLDFISH (CARASSIUS AURATUS L.). Chavin, Walter; Cukrowski, Christine A. (Wayne State Univ., Detroit). Radiat. Res., 34: 170-99(1968).

The physiological and cytological long-term effects of radioiodine (^{131}I) upon pituitary-thyroid relations in the goldfish (Carassius auratus L.) were studied in twelve groups of animals (control, 0.01 μCi to 2000 μCi). Thyroid evaluation included retention of a tracer dose of ^{131}I, autoradiography, follicle counts, epithelial cell height measurement, and histology. Pituitary evaluation was performed by three staining methods, cytologic definition of cell types and alterations, cell counts, and cell and nuclear measurements. The lowest dose reduced thyroid uptake to 37%, increased epithelial heights, and evoked abnormalities. Complete thyroidectomy occurred at 100 μCi. The pronephric thyroid showed a higher radiosensitivity than the pharyngeal thyroid. Differential thyroidectomy was achieved at 10 μCi. The pituitary changes paralleled thyroidal alterations. The thyrotrops degranulated. Large chromophobic cells appeared with the loss of thyrotrops. At higher doses, pituitary organization became less clear, and additional chromophobic cells appeared. Goldfish were extremely radiosensitive to ^{131}I even at the lowest doses used. The higher doses produced effects in the pituitary beyond those resulting from thyroidectomy. (auth)

36209 ULTRASTRUCTURAL ALTERATIONS OF HUMAN RECTAL MUCOSA AFTER IRRADIATION. De Dominicis, R.; Nori Bufalini, G.; Racheli, S. (Univ., Florence). Med. Nucl. Radiobiol. Lat., 10: 173-201(1967). (In Italian).

In order to supplement a previous study of histological modifications of human rectal mucosa after pelvic irradiation, an electronic microscope examination was made of ultrastructurally observable modifications after doses from 400 to 4,400 rad. Alterations of microvilli were found in the epithelium cells, with progressive diminution of intercellular adhesive mechanisms, as well as modification of the Golgi internal reticular apparatus. The basal membrane, which diminishes and nearly disappears with small radiation doses, thickens with higher doses. An initial increase in macrophagic-type connective cells is succeeded by an increase in fibroblast-type cells. Cells of plasmocytic type, usually abundant in rectal mucosa, diminish under prolonged treatment. In blood capillaries, radiation treatment does not appear to interfere with the opening up of endothelial cells, though there is initially an increase in ultrapinocyte processes. (TSS)

36210 INTERFERENCE BY X IRRADIATION WITH THE INDUCED SYNTHESIS OF TRYPTOPHAN PYRROLASE. Mishkin, E. Patricia; Shore, Moris L. (Public Health Service, Rockville, Md.). Radiat. Res., 33: 437-46(1968).

The effect of x irradiation on the synthesis of tryptophan pyrrolase following hydrocortisone and tryptophan administration was investigated in the liver of the intact male Sprague-Dawley rat. Twenty-four hours after sham or x irradiation of food- and water-deprived animals, either hydrocortisone or tryptophan was administered intraperitoneally. Enzyme levels in liver were obtained for the following 13 hours. It was found that radiation interfered with the hormonal induction of tryptophan pyrrolase. However, the time course of enzyme activity following tryptophan administration was not significantly affected by irradiation. (auth)

36211 INHIBITION OF GAMMA RAY INDUCED DEGRADATION OF E. COLI B_{s-1} DNA BY INFECTION WITH T1, T2, AND T4 BACTERIOPHAGE. Chapman, J. D.; Swez, J.; Pollard, E. C. (Pennsylvania State Univ., University Park). Nature (London), 218: 690-3(May 18, 1968).

An investigation is described on the effect of DNA degradation on parental DNA of T1 bacteriophage within the infected cell under radiation conditions which usually cause breakdown of host DNA. No release of DNA into the acid soluble trichloracetic acid fraction occurred even with previous exposure of the phage to heavy doses of ionizing radiation. This led to the speculation that bacteriophage T1 infection inhibited radiation induced DNA degradation. Experimental work is described indicating how the attachment of bacteriophages T1, T2 and T4 to actively degrading E. coli B_{s-1} is effective in completely inhibiting the host enzyme system within a few minutes of attachment. The molecular mechanism of the inhibition has yet to be elucidated. (UK)

36212 THYMIDINE INCORPORATION AS A MEASURE OF DNA-SYNTHESIS IN IRRADIATED CELL CULTURES. Painter, Robert B. (Univ. of California, San Francisco). Int. J. Radiat. Biol., 13: 279-81(1967).

Tritium-labeled thymidine and ^{14}C-orotic acid were incubated with HeLa cell cultures for two hours following exposure to various doses of x radiation. After incubation, the cells were washed and DNA was isolated and samples were counted in a scintillation spectrometer. The results showed that the uptake of ^{3}H-thymidine and ^{14}C-orotic acid was almost identical at each radiation dose. It was concluded that thymidine incorporation is an accurate measure of DNA synthesis in irradiated cell cultures. (C.H.)

36213 DISTRIBUTION OF RADIOACTIVE CALCIUM, STRONTIUM, BARIUM, AND RADIUM FOLLOWING INTRAVENOUS INJECTION INTO A HEALTHY MAN. Harrison, G. E.; Carr, T. E. F.; Sutton, Alice (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 13: 235-47(1967).

Plasma concentrations were measured for 7 days, and urinary and fecal excretions for 1 month or more, following intravenous injections of ^{47}Ca, ^{85}Sr, ^{133}Ba, and ^{223}Ra into a healthy man. The metabolism of ^{133}Ba and ^{223}Ra was very similar, so that Ba may be regarded as a good tracer for Ra. The difference in metabolism of ^{47}Ca and ^{85}Sr was quite marked. The ratios of the cumulative urine to the cumulative fecal excretion of the injected dose rapidly approached a constant value of 0.52 for ^{47}Ca, 0.24 for ^{85}Sr, 9.0 for ^{133}Ba, and 36.0 for ^{223}Ra. The calculated tissue uptake reached a maximum in about 1½ hours for ^{133}Ba and ^{223}Ra and at about 20 hours for ^{47}Ca and ^{85}Sr. For Ca, Sr, and Ba the derived tissue content was between 0.3 and 0.4 percent of the respective whole-body content. (auth)

36214 THE RETENTION OF ^{133}Ba IN MAN. Rundo, J. (Atomic Energy Research Establishment, Harwell, Eng.). Int. J. Radiat. Biol., 13: 301-2(1967).

The metabolism of ^{133}Ba in man was studied by means of whole-body counting up to 1000 days after intravenous injection of a tracer dose. Data on the biological half-life, early excretion, and retention times are presented. (C.H.)

36215 METABOLISM OF STRONTIUM. Colvin, Lonnie Benard. College Station, Tex., Texas A and M Univ., 1967. 95p.

Thesis.

The maximum concentration of ^{89}Sr observed in the blood of chicks following a single oral dose of the isotope was observed to occur in about two hours and decreased to a negligible quantity in 24 hours. The rate of ^{89}Sr uptake by bone was found to parallel the rate of increase in activity in blood to 14 hours post-injection time. The eyes took up radiostrontium in a similar way but in much lower concentrations. A simple surgical method was described for the separate collection of urine and feces in the chicken. The effects of administration route on the excretion pattern of radiostrontium were studied by this method. It was observed that oral ingestion resulted in the most efficient excretion, whereas the least efficient excretion followed intraperitoneal injection. A higher activity was found in urine rather than feces in all routes of administration except the oral route. Data collected on birds fed varying amounts of dietary Ca, indicated that the elimination of ^{89}Sr from the bone can be accelerated by a factor of four if the dietary Ca is increased from one to 3% when P is 0.5%. Of the soft tissues taken for analysis, only the eyes showed appreciable activity due to the bony scleral ossicles. When the dietary inorganic phosphate was varied, the minimum activity of ^{89}Sr was observed to be in the tissues of birds receiving the lowest dietary inorganic phosphate, and the activity of ^{89}Sr increased as the in-

organic phosphate of the diet increased. Data concerning the intestinal absorption and skeletal deposition of ^{89}Sr indicated that feeding verxite, a high purity hydobiotite, or sodium alginate, the sodium salt of a mucopolysaccharide from Pacific giant kelp, was ineffective in preventing absorption or deposition of ^{89}Sr in the chick. The rate of transference of ^{89}Sr from the shell to the embryo indicated that the uptake of ^{89}Sr closely paralleled the ossification of the embryonic bones. It was also observed that about one-third of the ^{89}Sr of the shell was withdrawn within six to 20 days of incubation, most of which could be accounted for in the developing embryo. Experimental bone growth anomalies produced by graduated replacement of the dietary Ca requirement by radiostrontium revealed that the bone ash of growing birds could be reduced significantly, at the expense of bone Ca, below that of the controls. This reduction was primarily at growing portions of the bones as evidenced by lowered bone Ca and reduced bone densities in these areas. Data from an investigation involving chicks fed diets in which one-half of the dietary Ca requirement was replaced by stable Sr and supplemented with various levels of vitamin D_3 indicated that one-half of the Ca requirement in the chick for growth may be met by Sr as long as the vitamin D_3 level was maintained at 500 to 1,000 ICU per kg feed. However, the total ash content, as well as the Ca content, of the bone decreased. The relationship of the length to the diameter of the tibiotarsus was altered only when vitamin D was totally excluded from the diet; however, the relationship of the diameter to body weight was significantly changed when the vitamin D level was reduced to 100 ICU per kg. (Disser. Abstr.)

36216 PHOTODIMER OF THYMINE IN ULTRAVIOLET-IRRADIATED DNA: PROOF OF STRUCTURE BY X-RAY DIFFRACTION. Camerman, Norman (Univ. of Toronto); Camerman, Arthur. Science, 160: 1451-2(June 28, 1968).

Dimethylthymine was photodimerized with ultraviolet radiation, and the structure of one of the resulting dimers, the cis 5,5:6,6 isomer, was determined by single-crystal x-ray diffraction. This isomer is the same as that obtained by ultraviolet irradiation of DNA; hence the structure of the thymine dimer in irradiated DNA is now proved. (auth)

36217 EFFECTS OF ULTRAVIOLET-MICROBEAM IRRADIATION OF VARIOUS SITES IN HELA CELLS ON RNA, DNA, AND PROTEIN SYNTHESIS. Takeda, S.; Naruse, S.; Yatani, R. (Mie Prefectural Univ., Tsu, Japan). Cytologia (Tokyo), 32: 96-104(Mar. 1967).

A selective portion of HeLa cells in culture was irradiated with a heterochromatic microbeam (about 2 μ in dia) for 25 sec, using a high-pressure Hg arc lamp (Toshiba 80-W) as an irradiation source. Biochemical effects on RNA, DNA, and protein synthesis were examined by labeling each with a tritiated precursor at various intervals. Autoradiographic observations showed that irradiation at a nuclear or extranucleolar nuclear site rapidly caused inhibition of RNA synthesis that was partly restored three to four hr and nearly completed 24 hr after irradiation. However, inhibition of DNA synthesis was fully manifested for several hours after irradiation and not restored within 12 hr. Protein synthesis was resistant to the irradiation of all cellular areas at the doses employed. (TSS)

36218 THE SENSITIVITY OF ESCHERICHIA COLI TO IONIZING PARTICLES OF DIFFERENT LETs. Munson, R. J.; Neary, G. J.; Bridges, B. A.; Preston, R. J. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 13: 205-24(1967).

Measurements were made of the inactivation doses for Escherichia coli exposed to α particles and protons of different LETs and also to γ rays. These were interpreted by target theory in terms of two types of lethal damage to the bacterial genome. Damage of type one affected only one strand of the DNA macromolecule and was partially reparable in vivo. Damage of type two following one track intersection of the DNA affected both strands and was irreparable. The identity of type one damage was uncertain; it did not appear to cause appreciable inactivation by producing base mutations but may lead to a lesion recognizable in vitro as a single-strand break. Type 2 damage probably corresponds to double strand scission of DNA as observed in vitro. (auth)

36219 ULTRASTRUCTURAL STUDY OF EARLY DEVELOPMENT OF VIBRISSAE IN NORMAL AND X-IRRADIATED EMBRYO MICE. Jacobson, C. M. (Univ. of Sydney). Aust. J. Zool., 15: 1109-22(Nov. 1967).

Mouse embryos were subjected to irradiation doses causing subsequent failure of vibrissa follicle development. The fine structure of the regions of skin that bear vibrissae was then examined and compared with the same structure in nonirradiated animals. At 10 days of development, prior to vibrissa initiation, the epidermis of facial skin consisted of two layers of very loosely connected and disorganized cells that had few cell inclusions. Subsequent development in nonfollicular areas included cell multiplication and increase in cell surface contact, in organization of the cell layers, and in the number of various inclusions. The elaboration of vibrissa rudiments was characterized by an accelerated rate and a much greater degree of these changes. There was particularly close cell contact across the basement membrane between the epidermal and dermal layers. The basement membrane was shown to consist of three layers. The median one was wide, light, and nongranular. The upper and lower layers were composed of lines of organized granules each several layers deep. These granules were in close association with the RNA-containing granules (ribosomes) of the epidermal and dermal cells. X irradiation disrupted the membrane organization within the cells, altered the arrangement of the cellular granules, and caused the disintegration of some. This effect was more violent and widespread in the vibrissa rudiments than in the nonfollicular regions. After x irradiation the normal linear arrangement of the basement membrane broke down to a greater extent in the vibrissa than in the unspecialized areas. Thus x irradiation halted development of vibrissae because, by disrupting the normal cell contacts and granular organization, it prevented the action of an induction system that functioned by the transport of vital substances by infection of particles through the granular layers. (BBB)

36220 PHOTOINDUCTION OF PLASTIDS AND OF CHLOROPHYLL IN A CHLORELLA MUTANT. Bryan, G. W.; Zadylak, Arlene H.; Ehret, C. F. (Argonne National Lab., Ill.). J. Cell Sci., 2: 513-28(Dec. 1967).

Wild-type Chlorella vulgaris, a unicellular alga that produces chlorophyll, develops its photosynthetic apparatus in either the presence or absence of light. C-10, a uv-light-induced mutant, differed from the wild type in its reduced capacity to synthesize chlorophyll in the dark, but resembled higher plants because it had a similar action spectrum for chlorophyll production. When C-10 was grown autotrophically in the light, however, it was indistinguishable from wild-type Chlorella grown under the same conditions. Stage-characterized populations of dark-grown heterotrophs of C-10 were studied to determine light-induced ultrastructural changes in plastids and in chlorophyll synthesis. Thylakoid development was followed through stages from prethylakoidal tubules to primary thylakoids that produced blebs. The blebs expanded and slid over the primary thylakoid, and then formed a secondary thylakoid; the process continued until the characteristic stacks of tertiary thylakoids were present in the mature chloroplast. A dramatic decrease in the rate of chlorophyll synthesis (early-rate-decline) was observed ~1 hr after onset of induction. This early-rate-decline correlated with the appearance of blebs on the primary thylakoid. Twelve hr after onset of induction, the photosynthetically impotent proplastid developed into a mature plastid containing stacks of disc-like thylakoids. Results with chloramphenicol, puromycin, and actinomycin D suggested that the early-rate-decline was associated with an insufficient rate of synthesis of the holochrome proteins. (BBB)

36221 POST-TRAUMATIC OSTEOPENIA. A QUANTITATIVE STUDY OF THE BONE MINERAL MASS IN THE FEMUR FOLLOWING FRACTURE OF THE TIBIA IN MAN USING ^{241}Am AS A PHOTON SOURCE. Nilsson, Bo E. R. (Malmo General Hospital, Sweden). Acta Orthop. Scand., 37: Suppl. 91, 1-55 (1966).

A monochromatic photon flux from a γ-emitting radionuclide simplifies data processing and permits, with certain approximations, the estimation of the actual mineral content of the bone tissue measured. The energy of ^{125}I had an energy too low to permit measurable transmission through the distal end of the femur using sources of a reasonable activity. Substantial differences in the attenuation properties of fat as compared to other constituents of the soft tissue may introduce substantial systematic errors. The spectrum derived from 0.7-Ci ^{241}Am source was compared with the spectrum obtained after attenuation of the radiation by the distal end of the femur of a human subject. The low energy radiation emitted from the source (26.9 keV γ rays and ^{237}Np L-shell x rays) was attenuated to a level where it essentially did not exceed background. The distal end of the femur attenuated the 59.6 keV γ radiation by a factor of up to 20. At the 59.6-keV photo peak background became negligible, and the transmitted intensity was a monoexponential function of the thickness of the attenuating matter. The mineral content of the distal end of the femur was evaluated in 116 cases of fracture of the tibial shaft by measurement of the attenuation of the ^{241}Am source beam. The time elapsed after injury varied from one month to 14 yr. The soft tissue was accounted for by a water phantom of the same thickness. (BBB)

36222 RESORPTION OF RADIOACTIVE-TAGGED SUBSTANCES FROM URINARY BLADDER AND ISOLATED SMALL

INTESTINAL LOOPS. Strohmenger, P.; Sack, H. (Univ., Muenster, Ger.). Urol. Int., 21: 538-48(1966). (In German).

A study was made of the absorption of 5- to 50-μCi doses of ^{45}Ca, ^{32}P, and ^{131}I-labeled inulin and p-aminohippuric acid from the urinary bladder and from operatively isolated small intestinal loops in the dog. Within 90 min, ^{45}Ca and ^{32}P were absorbed in up to 90% levels; no measurable quantities were taken up from the bladder. Resorption of ^{131}I-inulin and of ^{131}I-p-aminohippuric acid sometimes gave false clearance values. Inulin was not absorbed from the intestine or the bladder. Initially, the splitting of ^{131}I, which was dependent on pH values, and its subsequent absorption suggested inulin uptake. p-Aminophippuric acid was resorbed from the small intestine and also from the urinary bladder. Thus, ^{131}I-p-aminohippurate clearance studies were valid and comparable only when, during the entire experiment, urine was continuously evacuated. (BBB)

36223 THE EFFECTS OF IONIZING RADIATION ON CRYSTALLINE RIBONUCLEASE. Haskill, John Stephen. Toronto, Univ. of Toronto, 1966.

Thesis.

When dry crystalline bovine pancreatic ribonuclease was irradiated with ^{60}Co γ rays, a loss of enzymatic activity was observed. On the average, the absorbed energy required to inactivate each RNAase molecule was roughly comparable to the energy needed to produce one ionization, that is, from 20 to 70 eV. Since this energy, even if it were efficiently used, was sufficient to produce only a limited number of alterations in the RNAase molecule, the nature of the changes in the enzyme were studied from a biochemical point of view. The physical changes that occurred in the irradiated RNAse molecules are discussed. (Disser. Abstr.) (TSS)

36224 IMMUNOLOGICAL AND BIOLOGICAL PROPERTIES OF IODOINSULIN LABELED WITH ONE OR LESS ATOMS OF IODINE PER MOLECULE. Arquilla, Edward R.; Ooms, Henri; Mercola, Karen (Univ. of California, Los Angeles). J. Clin. Invest., 47: 474-87(Mar. 1968).

Purified radioiodoinsulin labeled with an average incorporation of 0.11 and 0.16 atoms of ^{125}I per molecule, respectively, had an attenuated ability to combine with specific antibodies compared to unlabeled insulin. To test whether the attenuated immunological characteristics of the purified iodoinsulin were due to radioactive degradation products that allowed only a portion of the antibodies in a given antiserum to combine with the labeled insulin, iodoinsulin at a concentration of 1 μg/ml by immune hemolysis inhibition was subjected to the Hales-Randle double antibody technique, using increasing amounts of the pooled insulin antiserum. It was possible to estimate whether or not all of the iodoinsulin was sufficiently intact to be bound by antibodies. It appeared that the attenuated immunological characteristics of radioiodinated insulins were due to distortions in conformations of antigenic determinants on the intact insulin molecules and not due to degradation products. (BBB)

Ecology

Refer to abstract 36261.

Genetics and Cytogenetics

Refer also to abstracts 36327, 36386, 36405, and 36407.

36225 BEARING OF FRACTIONAL-BODY MUTATIONS ON THE MUTATIONAL LOAD. Matsudaira, Yoriaki; Ito, Takashi (Univ., Tokyo). Idengaku Zasshi, 42: 221-6(Aug. 1967).

Two types of mutations, fractional and whole-body, that probably correspond to single- and double-stranded changes in the gene DNA are considered. The existence of fractional-lethals influences the estimation of the mutational load of a population. Calculations are presented for the mutational load of populations for three typical situations; both types of mutations are considered. It was concluded that since fractional mutations do not appear to increase linearly with radiation dose, the low-dose region of the calculated mutational load of irradiated populations is probably underestimated. (M.M.B.)

36226 SOMATIC MUTATIONS INDUCED BY CHRONIC GAMMA-IRRADIATION. Fujii, T.; Matsumura, S. (National Inst. of Genetics, Misima, Japan). Seiken Jiho, No. 19, 43-6 (Dec. 1967).

Seeds of heterozygotic corn (Zea mays) and rooted cuttings of two varieties of Chrysanthemum morifolium were planted at four different distances from a ^{137}Cs γ source (40 Ci), and both materials were exposed during 20 hr of each day over a two-month period. Total radiation doses ranged from 430 R to 4500 R. There were no appreciable effects on survival rate, plant growth, flowering time, or number of flowers even in plants exposed to the highest dose. Somatic mutations observed in corn leaves and chrysanthemum leaves and flowers following exposure of the material to various doses and dose rates of γ radiation are described. (C.H.)

36227 FREQUENCE OF APPEARANCE OF SPONTANEOUS AND RADIATION CHROMOSOME BREAKAGES IN LIVER CELLS. Kononenko, A. M.; Polyakh, N. Ya. (Central Research Inst. of Roentgenology and Radiology, Leningrad). Tsitologiya, 9: 1570-3(Dec. 1967). (In Russian).

From comparison of experimental and theoretical results, it is shown that in liver cells the probability of appearance of subsequent spontaneous and radiation breakages in the form of chromosome aberrations does not follow the Poisson distribution in which breakages are considered as independent events. After the appearance of the first effective breakage the probability of formation of the subsequent ones increases. Thus, the appearance of a breakage is not an obligatory local injury of a chromosome and it may induce such a change in the state of a cell that the probability of subsequent mutation increases. (auth)

36228 EFFECTS OF THE REPARATION INHIBITORS ON THE REVERSION FREQUENCY IN THE POLYAUXOTROPH STRAIN ESCHERICHIA COLI. Paribok, V. P.; Kassinova, G. V.; Bandas, E. L. (Inst. of Cytology, Leningrad. Ioffe Inst. of Physics and Tech., Leningrad). Tsitologiya, 9: 1496-1502(Dec. 1967). (In Russian).

The influence of acriflavine and caffeine on the reversion frequency in try, pro and his loci was investigated. Acriflavine and caffeine were not found either to change the frequency of spontaneous mutations in non-irradiated bacteria, or to influence mutation induced by uv irradiation when applied before the irradiation. A post-radiation effect of acriflavine did increase the mutation frequency in pro, his and try loci by 7.5, 16, and 31.5 times. Corresponding figures for caffeine in similar conditions are 2, 7.3, and 12.4. The frequency of spontaneous mutations as well as of mutations induced by uv irradiation without inhibitors appeared to be the lowest in locus try, being the highest in locus pro. (auth)

36229 GENES AFFECTING SENSITIVITY TO ULTRAVIOLET LIGHT IN THE malB REGION OF THE CHROMOSOME OF ESCHERICHIA COLI. Chung, Young S.; Greenberg, Joseph (Palo Alto Medical Research Foundation, Calif.). Genetics, 59: 11-22(May 1968).

The gene (uvr2) responsible for radiation sensitivity of strain Escherichia coli Bs2 is linked to both malB and metA, as shown by transduction with P1. The order of markers is metA malB uvr2. The gene uvrA was found in the same region of the chromosome, confirming earlier work of Schwartz. uvr2 appears to be closer to malB than is uvrA and pseudo-reciprocal crosses indicate that the order of markers is metA malB uvr2 uvrA. Some, but not all, Mal mutants in the malB region are pleiotropic with λ resistance, again confirming earlier data. The results suggest, but do not prove, that there may be two different malB cistrons, the malB λ^r cistron being more closely linked to the uv resistance genes in the region. (auth)

36230 THE RELATIONSHIP OF MUTATION RATE PER ROENTGEN TO DNA CONTENT PER CHROMOSOME AND TO INTERPHASE CHROMOSOME VOLUME. Sparrow, A. H.; Baetcke, K. P.; Shaver, D. L.; Pond, Virginia (Brookhaven National Lab., Upton, N. Y. Genetics, 59: 65-78(May 1968). (BNL-11721).

Mutation rates per roentgen based on the number of mutant cells which appeared on flower petals following acute irradiation with a ^{60}Co source were determined for five species of higher plants. The species studied were Tradescantia (clone 02), Tulipa HV golden harvest, Clematis jackmanii, Tropaeolum majus, and Gladiolus HV mansoer. The stocks used, except Clematis jackmanii, were heterozygous for flower color. Average mutation rates per roentgen were found to range from a low of 1.8 to a high of 149.2 mutant cells per 10^6 irradiated cells (Gladiolus and Tradescantia, respectively). Interphase chromosome volumes (ICVs), determined by dividing the nuclear volume of a species by its chromosome number, extended from a low of 3.6 μ^3 (Tropaeolum and Gladiolus) to 43.9 μ^3 (Tradescantia). Content of DNA per chromosome was estimated for each species by chemical extraction procedures. The amount of DNA per chromosome was found to be the highest in Tradescantia (4.9 pg) and the lowest in Gladiolus (0.1 pg). When ICVs and DNA content per chromosome were compared with mutation rates per roentgen, it was found that an increase in mutation rate per roentgen was highly cor-

related with an increase in both ICV and DNA per chromosome. A similar relationship was not found when mutation rate per roentgen was compared with nuclear volume or DNA content per cell. (auth)

36231 ELIMINATION OF X-RAY INDUCED ABERRANT CHROMOSOMES IN THE ROOT MERISTEMS OF TWO-ROWED BARLEY. Ikushima, Takaji; Ichikawa, Sadao (Univ., Kyoto). Idengaku Zasshi, 42: 271-8(Aug. 1967).

Chromosomal aberrations were scored during three successive cell generations in the root meristems of barley following x irradiation of 24 hr seeds with 300 R. Dicentric bridges and acentric fragments were observed at anaphase; dicentrics, rings, and deletions were observed at metaphase. Frequencies of these chromosomal aberrations decreased rapidly through the cell generations, especially of the dicentric bridges. The data were interpreted as an elimination of the cells carrying aberrant chromosomes from the meristematic cell population and was considered to result from reproductive failure after the loss of chromosome segments. (M.M.B.)

36232 GENETIC STUDIES ON AMYLASE OF DIFFERENT ELECTROPHORETIC MOBILITY PRODUCED BY STRAINS OF BACILLUS SUBTILIS. Yuki, Shohachiro (Univ., Kobe, Japan). Idengaku Zasshi, 42: 251-61(Aug. 1967).

Twelve amylase-negative mutants were isolated from uv irradiated spores of Bacillus subtilis. These mutants were used as recipients for transformation studies. Agar gel electrophoresis revealed differences among the amylases produced by different strains. The genes controlling the different amylases appeared to be allelic. (M.M.B.)

36233 RECOMBINATION-DEFICIENT MUTANT OF SALMONELLA TYPHIMURIUM. Wing, Jennifer P.; Levine, Myron; Smith, Hamilton O. (Univ. of Michigan, Ann Arbor). J. Bacteriol., 95: 1828-34(May 1968).

A recombination-deficient (Rec^-) ultraviolet-sensitive mutant of Salmonella typhimurium was isolated. The mutant grows more slowly than the wild-type strain and degrades its deoxyribonucleic acid extensively both during normal growth and after ultraviolet irradiation. Evidence is presented that a growing Rec^- population consists of two types of cells, one which can divide and one which cannot. (auth)

36234 GENETIC INVESTIGATION OF SUPPRESSORS OF A CHLOROPLAST MUTATION IN HORDEUM VULGARE. Tuleen, N. A.; Snyder, L. A.; Caldecott, R. S.; Hiatt, Vivian S. (Univ. of Minnesota, St. Paul). Contract AT(11-1)-332. Genetics, 59: 45-55(May 1968).

Genetic analysis of a selected group of 44 induced revertants of a barley mutant characterized by quantitative alteration of the major chloroplast pigments showed that most of the revertants resulted from mutations at suppressor loci. The 32 suppressor mutations placed on specific chromosomes by use of a tester set of translocations and a group of primary trisomics represent a minimum of 17 different loci. Intercrossing the 44 revertants in a large number of combinations has established the allelism of a pair of ethyl methanesulfonate-induced mutants, a pair of x-ray induced mutants, an x-ray- and a neutron-induced mutant at a locus on chromosome 6, and 11 mutants, 10 induced with x rays or thermal neutrons and one with polyfunctional triethylene melamine, at a second locus on the same chromosome. The latter locus appears to have an unusually high mutation rate in response to ionizing radiations, but no alleles at the locus have been found among the 23 EMS-induced suppressors analyzed for this purpose. All of the radiation-induced suppressors investigated were found to be recessive to their wild-type (non-suppressor) alleles, whereas approximately one-third of the chemically induced mutants behave as dominants. The fact that a majority of the suppressors are recessive appears to preclude nonsense suppression as their mechanism of action. (auth)

36235 ULTRAVIOLET SENSITIVITY GENE OF ESCHERICHIA COLI B. Donch, John; Greenberg, Joseph (Palo Alto Medical Research Foundation, Calif.). J. Bacteriol., 95: 1555-9(May 1968).

The ultraviolet sensitivity gene of Escherichia coli B was introduced into a K-12 recipient by transduction with phage P1. The uvs gene of E. coli B is cotransducible with the proC locus of K-12, is closely linked to tsx, is not linked to lacZ, and only rarely to purE. The transductants are mucoid, filamentous on uv irradiation, and show plating-medium response. The order of markers is lacZ proC tsx uvs purE. (auth)

36236 HEREDITARY CHANGES CAUSED BY X-IRRADIATION IN AMOEBA PROTEUS. Kalinina, L. V. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1543-9(Dec. 1967). (In Russian).

Induction of hereditary changes in amoebae was attempted by x irradiation (doses 30 to 50 kR). In the descendants of irradiated amoebae of the initial strains L and B, a destabilization was obtained in both the characters examined, i.e., in their stability to 0.15 M methionine and to 7% ethyl alcohol (similar destabilization effect was earlier recorded for other clones that are descendants of diheterokaryons containing L and B nuclei). The high frequency of hereditary changes resulting in destabilization of the clones grown from irradiated cells does not permit consideration of these changes as mutational in the narrow sense of the word. (auth)

36237 STATE OF SEX CHROMATIN IN PREIRRADIATED AND NONIRRADIATED MAMMARY CARCINOMA IN THE WOMAN: PRELIMINARY STUDY. Busch, W. (Pathologisches Institut des Staedtischen Krankenhauses, Berlin-Moabit, Ger.). Schweiz. Med. Wochensch., 98: 338-42(Mar. 2, 1968). (In German).

Previous studies showed that sex-chromatin-positive mammary cancers were characterized by a low degree of malignancy, a low mitotic index, a relatively high activity of citric acid cycle enzymes, and a high ratio of diploid tumor cells. The effect of irradiation on sex chromatin content of tumor cells was studied. The sex chromatin content was analyzed in 75 mammary carcinomas by use of thionine-stained nuclear preparations. Twenty-six carcinomas were γ-irradiated (^{60}Co). Heterochromatin analyses were carried out according to the method proposed by Kallenberger. Sex-chromatin-rich tumors were found to be more than twice as common in nonirradiated as in the irradiated group. On the other hand, sex-chromatin-negative carcinomas were one-third more frequent in the irradiated group than in the nonirradiated. Irradiation of the mammary carcinoma thus appeared to produce a fall in the sex chromatin content of tumor cell nuclei. (BBB)

36238 GAMMA RADIATION EFFECTS ON MODEL POPULATION OF DROSOPHILA MELANOGASTER. Zurabyan, A. S. (Inst. of Medical Radiology, Moscow). Biol. Zh. Arm., 20: No. 7, 25-31(July 1967). (In Russian).

Gamma radiation effects on the population dynamics of Drosophila melanogaster were studied over a period of 20 generations. One group was exposed to divided doses of 500 R and another group was irradiated at a single dose of 5000 R. Genetic analyses were made to determine the recessive lethal factional genes of chromosome II, the incidence of chromosome inversions, and the number of factional non-diverging x-chromosome mutations. Irradiation at 5000 R did not affect the number of insects in each generation except for the fourth and fifth generations which were somewhat lower in number. The number of recessive lethal factorial genes of chromosome II in populations irradiated with fractional doses reached 24% in comparison with 8% for the controls; in populations irradiated with a single dose it was 13%. In the divided dose irradiated population there were considerably more inversions than in the controls; in populations exposed to the single dose the incidence of inversions reached 48%. (R.V.J.) (TSS)

36239 APPARENT "DOUBLE MUTATION" INDUCED BY GAMMA RAYS. Cliver, D. O.; Anders, R. J. (Univ. of Wisconsin, Madison). Nature (London), 218: 187-8(Apr. 13, 1968).

From the experimental work described it was suggested that a portion of Coxsackie virus type A-9 (CA-9), strain P.B. (Bozek), when subjected to gamma irradiation, acquired a new antigenic specificity and the ability to infect cells of a new host species. It remains to be seen, however, whether these differences are true mutations and coincidental, or are two manifestations of a single genetically induced change in the coat protein. (UK)

36240 STUDIES ON THE INDUCED MUTATION BREEDING OF SOYBEAN FOR BACTERIAL BLIGHT RESISTANT TYPE. Lee, B. H.; Son, E. R.; Paik, D. K. (Kon-Kuk Univ., Korea. Korea Univ.). J. Nucl. Sci. (Seoul), 7: 35-8(Oct. 1967). (In Korean).

Soybeans were irradiated with x rays in attempts to induce mutants resistant to blight caused by Pseudomonas glycinea. Higher germination rates were observed at the higher dosages of 25 and 30 kR. Seedling reactions to the pathogen showed three that were resistant, 48,594 intermediate, and 8,626 that were susceptible. The three resistant plants were from one variety, one that had received 25 kR and two that had received 30 kR. (C.O.)

36241 STUDIES ON THE INDUCTION OF USEFUL MUTATIONS IN RADISH AND CHINESE CABBAGE BY IRRADIATION. Harn, Chang Yawl; Choung, Duck Yo; Choung, Dong Min; Lee, Joong Wha. J. Nucl. Sci. (Seoul), 7: 119-26(Oct. 1967). (In Korean).

In order to induce useful mutations for the improvement of radish and Chinese cabbage, several varieties of these crops were x irradiated. Although the germination ratio was not affected by

the x ray dosage, the length of time required for germination was prolonged with the increase of dosage applied. In the Chinese cabbage the delay of germination was noticed from 20 kR and in the radish from 60 kR. Bolting and flowering were delayed with the increase of x ray dose. Chlorophyll deficiency, curled leaves, chimera, and MS individuals were found in the R_1 generation. The number of flowers and fertility were slightly decreased. The fertility of the pistil of the MS individual was moderately high. The plant weight was increased with the increase of dosage in the Chinese cabbage but decreased in the radish. (auth)

36242 A NOTE ON TRANSLOCATION-TRISOMIC PLANTS FROM GAMMA-IRRADIATED BARLEY. Das, K.; Goswami, G. C. (Banaras Hindu Univ., India). Cytologia (Tokyo), 32: 55-8(Mar. 1967).

Two translocation-trisomic barley plants observed in some plants, var. K_{12}, grown from seeds were irradiated with γ rays. Trisomic plants were recovered in the R_3 generation from the progeny of a translocation heterozygote. One of the two plants, in addition to being a translocation heterozygote as revealed by a ring or chain of four chromosomes, was a trisome containing an extra chromosome. The plant had as high as 92% pollen sterility. In the present material, rings and chains of four were in equal proportion, and $7^{II} + 1^{I}$ and 7^{II} occurred in equal frequency. Although diplotene and diakinesis could not be studied in the present material, MI results revealed a big gap between the frequency of these two types of configurations. A 7-8 separation in all the AI cells scored in this material was in contrast with 7^{II} in MI seen in 6.98% sporocytes. The absence of 7-7 separation was probably related to inadequate sampling. High pollen sterility of this translocation-trisomic plant was significant although pollen mother cells (PMC) with an association of four chromosomes (either a ring or a chain) plus the extra chromosomes were seen only in 28% of the cells as compared to 65% of the PMC with other configurations. The deletion-duplication gametes formed by the translocation-trisomic plant were larger than expected. Also the viability of male gametes was apparently more effected by the extra chromosome. (BBB) (TSS)

36243 THE BEARING OF FRACTIONAL-BODY MUTATIONS ON THE MUTATIONAL LOAD. Matsudaira, Yoriaki (Rikkyo Univ., Tokyo); Ito, Takashi. Nippon Idengaku Zasshi, 42: 221-6(Aug. 1967).

Two types of radioinduced mutations, fractional- and whole-body mutations, probably corresponding to the single- and double-stranded changes of the gene DNA were considered in terms of previous studies on the dose-frequency relations for a wide range of x ray doses (400 to 3000 R). Visible mutations occurring as fractionals but arising in association with lethals were described. Since the existence of fractional-lethals must influence the estimation of the mutational load of a population, this factor was taken into consideration in calculating this load. A theoretical model and the calculations were presented for three typical situations, taking into consideration the existence of fractional (single-stranded) mutation besides whole (double-stranded) mutation. Detrimental effects associated with the former type of events were assumed to occur. If the following assumptions were allowed, namely that the spontaneous frequency of the fractionals was more than two times that of whole-body mutations, and that the probability of the genesis of a gonad from the mutant cell in a fractional individual was about ½ (no selective mechanism operating), it followed that the mutational load spontaneously arisen would have already exceeded the amount usually believed to be involved by a factor of two. (BBB)

36244 STUDIES ON THE SELECTION OF DESIRABLE LINES OF SOYBEANS AFTER X-RAYS AND THERMAL NEUTRON SEED IRRADIATIONS. Chang, Kwon-yawl; Bin, Yeoung-ho (Chinju Agricultural Coll., Korea). J. Nucl Sci. (Seoul), 7: 24-34(Oct. 1967). (In Korean).

Experimental studies clarified the effects of selection, estimated the heritabilities, and the genotypic correlations of some agronomic characters, and calculated the selection indexes for some characters of desirable lines. Seeds of three soybean varieties were irradiated at 30,000 R x-irradiation and two doses of thermal neutrons at 7.5×10^{12} and 10×10^{12} Nth/cm^2. Genotypic and phenotypic correlations in three generations of control plants and plants grown from the irradiated seeds are given in tabular form. Practical implications of these studies, especially on the selection index, were discussed. (C.O.)

36245 THE OXYGEN EFFECT BASED ON CHROMOSOME DAMAGE IN HeLa CELLS. Bushong, Stewart C.; Watson, Joseph A.; Wald, Neil (Univ. of Pittsburgh). Int. J. Radiat. Biol., 13: 249-60(1967).

HeLa cells in suspension were aerated with either oxygen or nitrogen while being irradiated with varying doses of 280 kVp x rays. The cells were examined during the first mitosis after irradiation for types and frequencies of chromosome aberrations. Analysis of the single-hit and multi-hit chromosome aberrations resulted in oxygen-enhancement ratios of 1.32 and 2.93, respectively. The oxygen enhancement ratio based on these relationships was 1:81. These studies indicated that HeLa cell chromosomes have a similar radiosensitivity, but a higher spontaneous aberration frequency, than that reported for normal mammalian cells. (auth)

36246 MASS-SCREENING TECHNIQUE FOR OBTAINING BACTERIAL BLIGHT RESISTANT MUTANTS IN SOYBEANS. Oh, J. H.; Mah, S. J.; La, M. K.; Kwon, S. H. J. Nucl Sci. (Seoul), 7: 134-7(Oct. 1967). (In Korean).

In breeding for disease resistance in soybeans, as well as other field crops, gene source of resistance must be obtained and the genes for resistance to certain disease must then be transferred into adapted varieties. In spite of a seriousness of the bacterial blight disease in soybean culture, no resistant variety was reported in this country. The mutation breeding method for obtaining a gene for bacterial blight resistance in soybean was used. The effective selection of a few desired mutants from a large population is a key to the success in mutation breeding programs. A mass-screening technique was adopted, but the artificial inoculation on young seedlings was not satisfactory especially in mid-summer experiments. The relation between temperature regulation and efficiency of artificial inoculation was considered helpful in screening for disease resistant mutants under the controlled condition in unfavorable season and in shortening the screening period by means of handling at early stages of plant development. (C.O.)

36247 THE STUDIES ON RADIOSENSITIVITY OF CULTURED NORMAL AND CANCER CELLS. I. MORPHOLOGICAL AND NUMERICAL STUDIES OF CHROMOSOMES IN X-IRRADIATED CELLS. Kang, Yung Sun; Kim, Yung Jin (Seoul National Univ.). J. Nucl. Sci. (Seoul), 7: 18-23(Oct. 1967). (In Korean).

The frequency of chromatid aberrations and the numerical analysis of chromosomes have been investigated in cultured human normal and neoplastic cells both in the condition of intact or x-irradiated. Primary cultured kidney and lung cultures of normal human fetuses were irradiated with 60R of x rays after 7, 14, and 21 days of incubation and cultures of uterine cervix carcinoma were irradiated after 17 days. In normal cells, more than 90% out of 2400 cells in both irradiated and control groups showed a diploid chromosome number of consistent counts of 46. The frequency of chromatid aberration was 5% in control group, while in the irradiated group it was about 32%. In cultured uterine cervix carcinoma cells, it showed that the chromosome number was ranged from 46 to 230 in both irradiated and control groups. The chromosome number distribution in that range was characterized by the existence of two distinct hypertriploid stem-cells, one consisting of cells with 60 chromosomes (17%), while the other included those with 64 chromosomes (36%). In the present experiments, the numerical variations of chromosomes according to kinds of tissues, culture periods, and sexes have not been found in both irradiated and control groups. (auth)

36248 CHROMOSOME ABERRATIONS IN IRRADIATED HUMANS. Bender, M.; Gooch, P. C. (Oak Ridge National Lab., Tenn.). Excerpta Med. Int. Congr. Ser., No. 105, 1421-5 ([1966]).

Chromosome aberrations of human leukocytes were studied following the in vitro irradiation of blood by hard x rays, ^{137}Cs γ rays, 14 MeV, 2.5 MeV, and fission spectrum neutrons, protons (20 MeV to 730 MeV) and ^{32}P β particles. A study was also made of chromosome aberrations of leukocytes of persons who had received whole-body irradiation during plutonium, uranium, and γ ray accidents and of some with accidental partial-body exposures to x rays. The coefficients of deletion production were determined and the persistence of aberrations for years after irradiation was noted. (F.M.M.)

Health Physics and Safety

Refer also to abstracts 35882, 36022, 36030, 36034, 36039, 36076, 36310, 36375, 37517, 37529, and 37623.

36249 (AD-661489) RESPONSE OF MAMMALIAN SKIN TO IRRADIATION WITH PARTICLES OF REACTOR DEBRIS. Krebs, J. S. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 15, 1967. 69p. (USNRDL-TR-67-118). CFSTI.

A survey of the relevant information in the biological and medical literature showed that serious radiation-induced acute lesions

of the skin are caused primarily by the destruction of the germinal layer cells of the epithelium. For an acute lesion to develop, the viable germinal cells must be reduced to a survival level of less than 0.001 over an area large enough so that cell proliferation in the margin of the exposure field will not be able to replace the dead cells. The principal type of delayed or late radiation-induced lesion of the skin is cancer. In rats and mice the development of cancer of the skin is consistently associated with the presence of acute lesions of the skin in the period following radiation exposure. The provisional standard recommended on the basis of experiments with rats is that a dose to the skin of 1500 rads or more, over a circular field of 4 mm radius or more, constitutes a potentially hazardous exposure condition. The fallout from destruction of a nuclear reactor is expected to be in the form of fragments and particles of various sizes. For separate particles likely to adhere to skin, approximate dose calculations have shown that only the beta emitting isotopes of higher energy maxima (1.5 MeV or greater) will be able to produce a radiation field large enough to be considered hazardous. If the particles fall on the skin in clusters, or if they are crushed and spread over the skin as a film of powder, the potential hazard will be much increased and the contribution of lower beta energies to the hazard will be significantly increased. (TAB)

36250 (CONF-660815) PROCEEDINGS FOR THE CONFERENCE ON PRINCIPLES OF RADIATION PROTECTION, AUGUST 24-26, 1966, OAK RIDGE, TENNESSEE. (Oak Ridge National Lab., Tenn. Oak Ridge Associated Universities, Inc., Tenn.). 175p. Dep. CFSTI.

Topics discussed include the development of the health physics profession, a review of research in health physics, the effects of radiation emitted internally, the stimulation of biology and biomedicine by the use of radioisotopes, the units of dosimetry, instrumentation for dosimetry, the health physicist's responsibilities in the medical profession, and health physics engineering. (W.H.K.)

36251 (DP-MS-68-1) PLAN FOR EMERGENCY ENVIRONMENTAL SURVEYS AT THE SAVANNAH RIVER PLANT. Johnson, J. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 9, 1968. Contract AT(07-2)-1. 18p. (CONF-680108-12). Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

Surveillance procedures were developed to estimate the radionuclide deposition and resulting population exposure problems in the event of an accidental release of radioactivity from a reactor or chemical separations plant at the Savannah River Plant. Ground survey routes and aerial survey flight patterns were established across twelve 30° sectors of the plant and environs. Car-borne scintillation instruments capable of detecting 0.5 $\mu Ci/m^2$ of ^{131}I are used to delineate areas of highest deposition. High-gain antennas installed on state forestry tower relay stations make possible constant communication with survey personnel. Miscellaneous equipment was constructed for the collection and field analysis of air, vegetation, and milk samples. Equipment check sheets and job assignments are used to avoid confusion and conserve time during organization of a survey. (auth)

36252 (HOHF-5) PROTECTION FACTORS OF SELF-CONTAINED COMPRESSED-AIR BREATHING APPARATUS. Adley, F. E.; Uhle, R. J. (Hanford Occupational Health Foundation, Richland, Wash.). [1966]. Contract AT(45-1)-1837. 11p. (CONF-680503-4). Dep. CFSTI.

From American Industrial Hygiene Conference, St. Louis, Mo.

Self-contained compressed-air breathing apparatus offer a wide range of protection to the wearer. The magnitude of the protection is dependent on whether or not the device is being operated on the demand or pressure-demand control, whether or not there is a serious defect in mask-to-face seal such as when glasses are worn, and whether or not the wearer is actively engaged in speaking or moving his head. Variations among manufacturers in mask and regulator design also result in protection differences. The testing, recommendations, and use of self-contained breathing apparatus are presented. (W.H.K.)

36253 (LA-3898) EFFICIENCY OF WHATMAN NO. 41 FILTER MEDIA AGAINST A POLYDISPERSE SOLID AEROSOL: INTERIM REPORT. Ettinger, Harry J.; Panowski, Thomas M.; Breckinridge, Charles E. (Los Alamos Scientific Lab., N. Mex.). Feb. 1968. Contract W-7405-eng-36. 13p. Dep. CFSTI.

A preliminary test program was carried out to evaluate the filtration efficiency of Whatman No. 41 filter media using a solid, polydisperse, submicron sodium chloride aerosol. Aerosol generator size characteristics and mass output were calibrated as functions of operating pressure and NaCl solution concentration. Whatman No. 41 filter efficiency was measured as a function of filtration velocity. Test results indicate that filter penetration differs significantly for solid or liquid test aerosol. (auth)

36254 (LA-DC-9005) SURFACE CONTAMINATION CONTROL AT THE LOS ALAMOS CHEMISTRY AND METALLURGICAL RESEARCH BUILDING. Enders, John W. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 23p. (CONF-680503-2). Dep. CFSTI.

From American Industrial Hygiene Conference, St. Louis, Mo.

Monitoring techniques and operational philosophy used for the control of surface radioactive contamination at the Chemistry and Metallurgical Research Building, Los Alamos Scientific Laboratory, are discussed. A 15-year review of these methods, instrumentation, and record keeping is also presented. (auth)

36255 (NTO-T-0022) FUNDAMENTALS OF RADIATION SAFETY FOR NERVA TEST OPERATIONS PERSONNEL. (Westinghouse Electric Corp., Jackass Flats, Nev. Aerojet-General Corp., Jackass Flats, Nev.). Apr. 1967. 83p. Dep. CFSTI.

The basic fundamentals of radiation safety are reviewed. These are characteristics of nuclear radiation, measurement of radiation, biological hazards of radiation, principles of radiation detection, and protection from radiation. Four appendices are also included on x radiation, criticality accident reports, historical background of nuclear physics, and radiation standards. (B.G.D.)

36256 RADIONUCLIDES IN THE UNITED KINGDOM DIET, 1962-1964. Bruce, R. S. Radiol. Health Data Rep., 7: 331-4(June 1966).

In continuing United Kingdom diet studies, a fourfold increase in ^{90}Sr contamination of the average diet was observed between 1961 and 1964. The ratio of ^{90}Sr to calcium in the average mixed diet in 1964 was 25.9 pCi/g (corresponding to an intake of 28.5 pCi/day) that is nearly three times the value in 1959. During 1962 to 1964, the relative contributions of ^{90}Sr from different types of food remain fairly constant. Cesium-137 levels increased markedly between 1961 and 1963, the estimated daily intake, based on assays of five types of food, rising from about 30 to 170 pCi/day; in 1964 the value was 160 pCi/day. Measurements of ^{85}Sr and ^{140}Ba during 1962 and 1963 indicated that these isotopes were minor radioactive contaminants of the diet. (auth)

36257 SECTION I. MILK AND FOOD. Radiol. Health Data Rep., 7: 335-52(June 1966).

Data are presented on the routine monitoring of the ^{89}Sr, ^{90}Sr, and ^{137}Cs content of milk in North America and Pan America during Feb., 1966. The ^{90}Sr content of whole liquid milk in New York City during July to Sept., 1965 is reported. State milk surveillance activities are given for California, Oregon, and Washington, reporting the ^{90}Sr and ^{137}Cs content of milk during Oct. to Dec., 1965, and presenting annual summaries for 1964 and 1965. Reports on food and diet surveillance activities include: ^{90}Sr content of human diet in New York City, San Francisco, and Chicago during Aug. to Oct., 1965, and the estimated daily intake of radioisotopes in California diets during May to August, 1965. The gross beta-radioactivity content of surface waters in the United States for Dec., 1965, the ^{90}Sr activity in surface waters in the United States for April to Sept., 1965, the ^{89}Sr and ^{90}Sr content of surface waters in New York for June to Dec., 1965, and the ^{90}Sr content of tap water in New York City during July to Nov., 1965, are given. The gross beta-radioactivity content of airborne particulates and precipitation in North America and Pan America are given for Feb., 1966. Strontium-90 content of human bone in the United States during the first quarter of 1965 is given, and the environmental levels of radioactivity of Brookhaven National Laboratory, and Rocky Flats Plant are recorded for July to Dec., 1965. The Atomic Energy Commission announced seven underground nuclear tests during May, 1966, and Communist China exploded her third nuclear device during May, 1966. (E.R.B.)

36258 RADIOACTIVITY IN MILK IN THE UNITED KINGDOM, 1962-1965. Bruce, R. S. Radiol. Health Data Rep., 7: 326-30(June 1966).

Radiochemical analyses of raw milk produced in the United Kingdom showed that in 1962 the total ^{131}I in milk was about 85 percent of that found in the autumn of 1961; subsequently, levels have remained below the limit of detection. Concentrations of ^{90}Sr and ^{137}Cs increased sharply in 1962 and again in 1963, reaching maximum levels in the middle of the year. Since then, apart from seasonal fluctuations, there was a general decrease in contamination. The annual average ratio of ^{90}Sr to calcium in milk in the United Kingdom increased from 5.9 pCi/g in 1961 to 28 pCi/g in 1964, and fell to 19 pCi/g in 1965. The mean concentration of ^{137}Cs changed similarly, the values for 1964 and 1965 being, respectively, 153 and 98 pCi/liter. (auth)

36259 GAMMA RAY SPECTRA OF THE RADIOACTIVE FALLOUT WITH A Ge(Li) DETECTOR. Hattori, Manabu; Nagahara,

Teruaki (Rikkyo Univ., Yokosuka, Japan). J. Radiat. Res., 8: 125-31(Sept.-Dec. 1967).

The measurement of the gamma ray spectra from the radioactive fallout produced by the fifth and sixth Chinese nuclear test explosions was made with a Ge(Li) detector. Many nuclides were identified in the gamma ray spectra without any chemical processing. The fission products as ^{85m}Kr, $^{91}Sr-^{91m}Y$, $^{95}Zr-^{95}Nb$, $^{97}Zr-^{97}Nb$, $^{99}Mo-^{99m}Tc$, ^{103}Ru, ^{131}I, $^{132}Te-^{132}I$, $^{133}I-^{133}Xe$, ^{139}Ba, $^{140}Ba-^{140}La$, ^{141}Ce, ^{143}Ce, and ^{147}Nd were identified. In addition to them, ^{237}U and ^{239}Np produced from ^{238}U were also identified. (auth)

36260 COLORADO DENTAL X-RAY MACHINE SURVEY, 1961–APRIL 1965. Alcox, R. W.; Downs, R. A.; Jacoe, P. W. Radiol. Health Data Rep., 7: 319-25(June 1966).

Results of a two-phase program for examining dental x-ray machines showed marked progress by the dental profession in correcting equipment and procedural deficiencies identified by mail order surveys and physical surveys conducted by the Colorado State Department of Public Health. The first phase of the program was a Surpak mail order survey and the second phase was a physical survey using standards recommended by the U. S. Public Health Service for x-ray beam diameters, filtration of the primary beam, beam definition, and leakage. Following the first phase of the study, the number of machines having beam diameters of 2.75 inches or less increased from 48 to 73 percent; following modifications during the physical survey phase, 85 percent of the machines met the standards. Improvement in meeting filtration standards is shown in a rise from 25 percent compliance during the first survey to 74 percent. During the physical surveys, many areas of dental radiographic practice were examined and specific changes were made or recommended to minimize exposure to both patients and dental personnel. The most common procedural errors observed were overexposure and inadequate development of film. (auth)

36261 GIDROFIZICHESKIE ISSLEDOVANIYA TIKHOGO I ATLANTICHESKOGO OKEANOV V KRUGOSVETNOM PLAVANII NIS "MIKHAIL LOMONOSOV". (Hydrophysical Studies of the Pacific and Atlantic Oceans during the Around-the-World Expedition of "Mikhail Lomonosov"). Boguslavskii, S. G.; Lundberg, O. R. (eds.) Sevastopol', Izdanie MGI AN USSR, 1967. 211p.

Data collected during an around-the-world voyage of the scientific research ship Mikhail Lomonosov are treated in the 36 articles. The first seven articles are concerned with studies on radioactivity of the atmosphere, distribution of artificial radionuclides in the ocean, strontium content of plankton of the Atlantic and Pacific oceans, uptake of fallout radionuclides by plankton, distribution of zooplankton in waters of Tuamotu Archipelago, and radioactivity of the bottom residue of the ocean. The next six articles deal with hydrological and hydrochemical studies including the Gulfstream current, biochemical processes in sea water, and spectrophotometric determinations of nitrate and nitrite nitrogen. The two following chapters deal with hydrophysical and hydrographical studies. Automatic recording and computer data are treated in a special chapter on experimental data. The last chapter includes data on the physicomechanical properties of bottom residue of the Pacific Ocean, geological characteristics of the bottom residue of the Atlantic Ocean, and distribution of various elements in the bottom of both oceans. (H.L.W.)

36262 SCHEMA FOR ABSORBED-DOSE CALCULATIONS FOR BIOLOGICALLY-DISTRIBUTED RADIONUCLIDES. Loevinger, Robert; Berman, Mones. J. Nucl. Med., Suppl. No. 1, 9-14(Feb. 1968).

Methods for the calculation of absorbed dose only for biologically distributed radioisotopes are presented. The absorbed dose calculations for both homogeneous and inhomogeneous media are developed around the concept of absorbed fraction and an extension of the concept, the specific absorbed fraction. Input data that must be known are fractions and energies in the radioisotope disintegration scheme, the model (which includes the kinetics of the radioisotope in the organs of the body), buildup factors and absorbed fractions, and specific absorbed fractions between sources and targets. The equations are given in a system of units that yield the absorbed dose in rads if the source activity is given in μCi; time is given in hours. It is illustrated how the equations may be applied to specific types of radiation, i.e. non-penetrating, penetrating, and penetrating photon radiations. (B.S.L.)

36263 YEARLY CHANGES OF RADIATION EXPOSURE DOSES RECEIVED BY WORKERS IN RADIOLOGICAL OCCUPATIONS AT KYUSHU UNIVERSITY HOSPITAL. Irie, Hideo; Takei, Chikara; Momii, Shigeki; Higuchi, Takehiko; Okamura, Sigeaki; Masuda, Kouji (Kyushu Univ., Fukuoka). J. Radiat. Res., 8: 116-24(Sept.-Dec. 1967).

The yearly changes of the exposure doses received by workers in radiological occupations at Kyushu University Hospital from September 1962 to March 1966 were reported. The exposure doses gradually decreased every year. It was noted that there was a marked decrease in the γ-ray exposures, and there was a notable decrease in the doses received by nurses. However, the x-ray exposure doses received by non-radiologists show a slight increase. Further efforts should be devoted to reduce the exposure doses received by workers. Education in radiation disturbances and information on scattered rays as well as training in radioisotope handling should be continued. (auth)

36264 IRRADIATION PLANNING WITH ELECTRONIC CALCULATORS. Schoknecht, G. (Staedtische Auguste-Viktoria-Krankenhouses, Berlin). Fortschr. Geb. Roentgenstr. Nuklearmed., 108: 95-104(Jan. 1968). (In German).

With the aid of digital electronic computers exact treatment planning was possible. For determining the dose distribution with multi-field and moving-field therapy using ^{60}Co a computation method was employed that was based on the representation of the stationary field by decrement lines. A generally valid formula was used to calculate the dose distribution on the central beam. The dose distribution in the direction perpendicular to the central beam was reproduced with the aid of measured data. The computer supplied the result in the form of a distribution diagram that corresponded to an isodose chart. The practical application of the method for treatment planning was shown with the aid of examples. (auth)

36265 INDUSTRIAL USE OF RADIOACTIVE SOURCES. SEALED GAMMA RADIATION SOURCES FOR GAMMA RADIOGRAPHY. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl. No. 52, 15p.(Mar.-Apr. 1965). (In French).

The radioactive elements used in γ radiography include ^{60}Co, ^{137}Cs, ^{192}Ir, and ^{170}Tm. This brochure describes the hazards stemming from the radiation emitted by them and lists the precautions to be taken in their industrial use, on the basis of directives drawn up by various international bodies (ICRP, ILO, EURATOM) which are applicable in France. The use and storage of apparatus and source containers and the action to be taken in the event of accidents on public thoroughfares, in workshops, or on building construction sites, and in the event of fire are considered. The formalities required in obtaining authorization to procure or use radioactive elements are described. (Occup. Safety and Health Abstr.)

36266 RADIATION PROTECTION IN INDUSTRY. Kaufmann, E. pp 54-61 of Radioisotope in der Industriellen Messtechnik. Bern, Schweizerische Vereinigung fuer Atomenergie, 1965. (In German).

A review is given of the relevant Swiss legislation concerning radiation protection in industry, the activities of the Swiss inspection authorities, and the qualifications that experts must hold. Radiation protection in the use of sealed-source measuring instruments (thickness gauges, level indicators, density and moisture content measuring instruments with a neutron source, gas chromatography equipment, etc.) is also discussed. (Occup. Safety and Health Abstr.)

36267 BIOLOGICAL EFFECTS OF RADAR. Benitte, A.-C. Concours Med., 88: 3667-80(May 21, 1966). (In French).

Radar waves may exercise a dual effect on man, namely a heating effect, the extent of which depends on the duration of exposure and radiation frequency, and which chiefly affects the eyes, the brain, and the gonads and a specific effect (neurovegetative disorders, and an increase in the total hemolysis rate). The permitted limits of exposure in France were given as follows: for energy densities under 0.01 W/cm^2, exposure may be protracted, whereas it should not exceed 1 min at densities of 3 W/cm^2. Adequate protection is secured by establishing a prohibited-access area around radar aerials and providing workers with screens and with absorbing and reflecting clothing. Radar operators are subject to visual and aural fatigue that is eliminated by rest. (Occup. Safety and Health Abstr.)

36268 RADIATION CONTROL METHODS AT PLUTONIUM LABORATORY IN JAERI. Onishi, Takeshi (Japan Atomic Energy Research Inst., Tokyo). Hoken Butsuri, 1: No. 1, 8-11 (Sept. 1966). (In Japanese).

Radiation control methods at a plutonium laboratory, such as contamination control, room air monitoring, stack dust monitoring, and monitoring of solid and liquid wastes are described. (auth) (NSA of Japan)

36269 DECREE NO. 67-228 OF 15 MARCH 1967 CONTAINING ADMINISTRATIVE REGULATIONS CONCERNING THE PROTECTION OF WORKERS FROM THE HAZARDS OF IONIZING RADIATION. J. Offic. Repub. Fr., No. 69, 2754-71(Mar. 22, 1967). (In French).

This Decree replaces the Decree of 5 December 1934 and

Orders of 26 December 1934 concerning the protection of workers from radioactive substances and radiation. It contains provisions designed to safeguard workers in the medical, industrial and commercial fields: anyone in possession of radiation generating equipment or of a natural or artificial radiation source must declare same to the Labour Inspectorate; records must be kept of the characteristics of and any modifications to the source, of the uses made of it and of staff employed; technical provisions are laid down regarding the extent of monitored areas, and radiation dosimetry; workers under regular medical supervision must have a special record, to be kept by the responsible occupational physician and preserved throughout their life; a register of dates, length and cause of absences from work and of results of haematological and radiological tests to be maintained. Special provisions cover certain mobile or sealed sources and medical applications; data on maximum equivalent doses and concentrations are appended. (Occup. Safety and Health Abstr.)

36270 MODERN SURGICAL INSTALLATION FOR CASES OF NUCLEAR ACCIDENTS. Rodriguez, E. Ramos. Energ. Nucl. (Madrid), 11: 561-6(Nov.-Dec. 1967). (In Spanish).

The installation at Hanford for the care and treatment of patients injured in nuclear accidents is described and illustrated. (J.S.R.)

36271 LEGAL PROBLEMS IN RELATION TO LESIONS CAUSED BY IONIZING RADIATIONS. Corretjer, Luz. Energ. Nucl. (Madrid), 11: 551-8(Nov.-Dec. 1968). (In Spanish).

The examination of the various legal problems arising from radiolesions in persons professionally exposed can be divided into two distinct areas: the legal obligations to provide safety and protection precautions against ionizing radiation; and reparation to the person injured by exposure. The first aspect is only briefly considered. The second aspect is considered in some detail on the basis of a French decision in a case of illness attributed to ionizing radiation. The decision was based on an evaluation of the professional character of the illness and of the radiations received. (J.S.R.)

36272 MONITORING AND EVALUATION OF INHALED AIRBORNE RADIOACTIVE MATERIALS. Fukuda, Seiji; Sakagishi, Shokichi (Japan Atomic Energy Research Inst., Tokyo). Kuki Seijo, 4: No. 5, 40-51(Feb. 1967). (In Japanese).

Monitoring and detection methods for air contamination due to radioactive materials in the working environment are reviewed from the viewpoint of the evaluation and protection of the inhalation hazards. Two air monitoring systems adopted at Tokai Research Establishment, JAERI, are described. One is a system consisting of general air monitoring, local air monitoring and spot air monitoring, and the other is a concentrated air monitoring system. The problems of siting a fixed-position air sampler and of the dominant particles are discussed in relation to the methods of obtaining better correlation between the radioactive concentration in air and the inhaled activity. Comparison of data obtained by the local air sampler and by the personal air sampler is made. Characteristics of size selective sampler and cascade centripeter that were recently developed on the basis of respirable dust concept are described. In addition to the sampling and evaluation of the radioactive particulates, a sampler developed at JAERI to determine the concentration of airborne radioiodine that is released during the normal operation of radioisotope production plant and hot laboratory, and its performance on the collection efficiency under the various sampling conditions are introduced. (NSA of Japan)

36273 ASSURANCE OF RADIATION SAFETY IN SPACEFLIGHTS (RADIOBIOLOGICAL ASPECTS). Grigor'ev, Yu. G.; Kovalev, E. E. Kosm. Biol. Med., 1: 64-9(1967). (In Russian).

Some problems of assuring radiation safety during short- and long-term spaceflights, i.e., formulation of safety criteria, evaluation of restoration processes after repeated exposure to radiation, determination of the degree of radiation damage during space flight, and the development of methods for preliminary estimation of cosmonaut radiosensitivity are discussed. Data on radiation conditions in space are presented in tabular form. A permissible dose for astronauts of 15 per mo was recommended. Results of investigations on the effects of protons on some plants are presented. RBE coefficients of 126 and 660 MeV protons for various cultures determined by different evaluation criteria fluctuated from 1.5 to 5.5 and higher and were directly dependent on dose. (TSS) (ATD)

36274 ENERGY DEPOSITION IN WATER BY PHOTONS FROM POINT ISOTROPIC SOURCES. Berger, Martin J. J. Nucl. Med., Suppl. No. 1, 17-25(Feb. 1968).

Buildup factors and related data which describe the deposition of energy by photons in a water medium are presented. Nineteen photon source energies between 15 keV and 3 MeV are included. Data are given on energy-absorption buildup factor for point isotropic sources in water, coefficients of polynomial representation of energy-absorption buildup factors for water, specific absorbed fractions and absorbed dose rates in water and muscle, and radii of spheres for specific absorbed fractions. (W.H.K.)

36275 ABSORBED FRACTIONS FOR PHOTON DOSIMETRY. Brownell, G. L.; Ellett, W. H.; Reddy, A. R. J. Nucl. Med., Suppl. No. 1, 29-39(Feb. 1968).

The photon absorbed fraction, which is the fraction of the emitted photon energy that is absorbed by a volume, depends on the source and absorber geometry, the photon energy, and the intervening material. Data from Monte Carlo calculations of absorbed fractions for a number of geometries and photon energies are presented. (W.H.K.)

36276 RADIATION MONITORING IN THE ELECTRICAL COMMUNICATION LABORATORY. Kudo, Kiyoshi; Tamura, Hidemitsu (Electrical Commun. Lab., Tokyo). Hoken Butsuri, 1: No. 1, 2-7(Sept. 1966). (In Japanese).

The experience in radiation monitoring at the Electrical Communication Laboratory is reported. Personnel monitoring, laboratory monitoring, and field monitoring are the main activities in the laboratory and have been carried out from 1962 to the present time. The methods of monitoring and the working limits are similar to those used in the Japanese Atomic Energy Research Institute. The personnel exposure to radiation, the frequency distribution of white blood cells, the radiation levels for the contamination of floor surfaces in the laboratory, and the concentration of radioactive waste water were measured. These data showed that no significant exposure was present for the personnel. Furthermore, it was shown that the radiation levels were kept lower than the maximum permissible levels. (NSA of Japan)

36277 DERIVATION OF THE WORKING LIMITS OF THE SKIN SURFACE CONTAMINATION. Minami, Kentaro; Fukuda, Seiji (Japan Atomic Energy Research Inst., Tokyo). Hoken Butsuri, 1: No. 1, 20-30(Sept. 1966). (In Japanese).

Limits of contamination on the skin surface, employed as a guide for the radiation protection for occupationally exposed individuals, were derived by taking into account the external exposure dose to the skin and the internal exposure dose received by the inhalation, ingestion, and skin penetration of the contaminants. The adequacy of the derived limits is discussed in relation to the detection probability of a hand-foot monitor for hand contamination. The contamination limits for the skin, that were adopted in other establishments, are also reviewed. (NSA of Japan)

36278 FILLABLE ANTHROPOMORPHUS PHANTOM FOR CALIBRATION OF WHOLE-BODY COUNTERS. Poulheim, Karl-Friedrich (Staatliche Zentrale fuer Strahlenschutz, Berlin). Strahlentherapie, 135: 217-19(Feb. 1968). (In German).

An anthropomorphous phantom was used for the calibration of a whole-body counter. Organs which were of particular importance to radiation biology, were built-in into the phantom and could be filled from outside by special devices. The phantom was constructed in such a way that the entire body as well as parts of the body could be filled with solutions of different composition. (auth)

36279 COMPARISON OF DOSE PATTERNS IN A DOG EXPOSED TO NEUTRONS AND X-RAYS. Wingate, Catharine L.; Page, N. P.; Ainsworth, E. J. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 32: 404-16(1967).

Dose distributions with depth in a dog cadaver and in a cylindrical phantom were obtained for 1-MVp x rays and for mixed neutron and γ radiation from a reactor. Measurement of γ-ray or x-ray dose was made with LiF thermoluminescence dosimeters, while neutron dose was obtained from the activation of small sulfur disks calibrated against tissue-equivalent ionization chambers. Penetration of the 1-MVp x rays was considerably higher than that of the reactor neutrons. Depth-dose distributions for the 1-MVp x rays did not differ significantly in various cross sections of the body, contrary to results for 250-kVp x rays reported by other workers. Local distortion of isodose curves due to bone could be discerned. For the reactor beam administered unilaterally, the energy deposition was strongly asymmetric. Isodose configurations for the neutron and γ ray components differed substantially. However, only minor variations were found in the depth-dose curves for different sections through the dog cadaver in spite of differences in composition and density. Distortion of dose curves in bony regions was not discernible, but small differences in the neutron and γ ray components were noticeable in the lung. (auth)

36280 PELVIMETRY. Bean, William J.; Cook, Robert T.; Eavenson, Lester W.; Bristow, Louis J. (Southern Baptist Hospital, New Orleans). Radiol. Clin. N. Amer., 5: 29-46(Apr. 1967).

Ways of minimizing the dangers of irradiation of the fetus during x-ray pelvimetry are explained. It is pointed out that it is important for the radiologist to know how much irradiation is given to the mother and fetus by each x-ray examination, and to implement necessary changes to minimize the amount of radiation that will be absorbed in a given examination. Knowledge already available proves that the amount of radiation from a given examination can be minimized with present techniques and equipment. High-speed film, high-speed intensifying screens, high kilovoltage, accurate collimation of the beam, longer target-film distances, and adequate filtration all help to decrease patient irradiation. The use of the image intensifier in place of the usual fluoroscopic screen can decrease the R/min rate to $1/10$ or $1/20$ that of regular fluoroscopy. Many reports of the amount of irradiation of the fetus are misleading. Skin dose to the mother is no indication of the dose a fetus receives. A considerable amount of the x rays is filtered out by the overlying skin and soft tissues of the mother. Accurate calculations of the radiation dose to the fetus were made by extrapolation of the surface dose to the dose absorbed at a 10-cm depth for various exposures. It was shown that the dose can be reduced $2/3$ by institution of fast film and high-speed screens alone. It has been suggested that the 90- to 100-kV range and at least 2-mm Al filtration can decrease the dose from any examination by 50% as compared with the 70-kV and 0.5-mm Al (the usual exposure factors) technique. Adequate collimation of the x-ray beam to only the area of interest also reduces irradiation of the patient to a minimum. This is especially important for the fetus since it is more sensitive to irradiation than the adult. (TSS) (BBB)

36281 SHUTTER SYSTEM REDUCES LASER HAZARDS. Koch, Norman (Bissett-Berman Corp., Santa Monica, Calif.). Microwaves, 6: 129-30(Mar. 1967).

A simple arrangement of lenses and a camera shutter that allows permanent or temporary variation of observation time and of the laser beam diameter without disturbing the overall experimental arrangement is described. The system consisted of a short focal length lens, a longer focal length lens, and a removable camera shutter. Exposure of personnel during the experiment was minimized by selecting a suitably fast shutter speed. (IAA)

36282 COMPARISON OF ^{131}I INTAKE FROM MILK AND NON-MILK FOODS. Thompson, J. C. Jr. (Cornell Univ., Ithaca, N. Y.). Health Phys., 14: 483-8(May 1968).

Non-milk ^{131}I intake could make a significant contribution to total ^{131}I intake among certain population groups. Estimations were made for some of these groups during the June to September 1962 period. The possibility of a 20–40% non-milk ^{131}I contribution was indicated for farm families, rural families with gardens, and other non-urban population categories. Since there are nearly 50 million persons in the United States included in these groupings, the nature and magnitude of this contribution should be more carefully examined. The solution to the problem may simply require converting to processed foods when the occasion demands action, but no procedures or plans have been established to meet this need. (auth) (UK)

36283 ^{90}Sr IN CALIFORNIA MULE DEER. French, Norman R.; Bissel, Harold D. (Univ. of California, Los Angeles). Health Phys., 14: 489-94(May 1968).

The strontium-90 and calcium concentrations of the mandibles (plus teeth) of 250 mule deer (Odocoileus hemionus) were determined. The animals were collected at 13 localities in California between 1958 and 1961. The data were analyzed to evaluate correlation of ^{90}Sr in bone with a number of biological and environmental variables. There was no statistically significant difference in the mean ^{90}Sr content of teeth and bone from the mandibles. Higher mean values of ^{90}Sr concentration occurred in northern California than southern California. Variation in ^{90}Sr concentration was associated with latitude, year of collection, age of the animal, and rainfall of the location of collection. (auth)

36284 ELECTRON THERAPY DOSIMETRY. Steuart, W. J. (Sydney Hospital). Australas. Radiol., 11: 370-3(Nov. 1967).

Dosimetry measurements were made on the electron beam from a 6 MeV linear accelerator used for superficial therapy. Basic measurements were made of depth dose using a flat ionization chamber. Contamination of the beam by x radiation was measured using a slab of perspex placed in front of the ion chamber. The geometrical distribution of electron intensity in the plane at right angles to the center axis of the beam was also determined by moving the ion chamber to points spaced 15 cm apart. (C.H.)

36285 FILM DOSIMETRY IN RADIATION THERAPY. Fehrentz, Dieter; Zunter, Franjo (Univ., Heidelberg). Strahlentherapie, 135: 301-6(Mar. 1968). (In German).

The factors influencing the film response when exposed in a water-equivalent phantom were studied as functions of depth and oblique incidence. The beam of a telecesium and a telecobalt unit were examined as well as 15-MeV photons and electrons. A phototechnical film, Gevatone N-33, of the Gevaert-Agfa concern was used, without any filter, and wrapped only in black paper. (auth)

36286 THE M. D. ANDERSON METHOD FOR THE COMPUTATION OF ISODOSE CURVES AROUND INTERSTITIAL AND INTRACAVITARY RADIATION SOURCES. III. ROENTGENOGRAMS FOR INPUT DATA AND THE RELATION OF ISODOSE CALCULATIONS TO THE PATERSON–PARKER SYSTEM. Stovall, Marilyn; Shalek, Robert J. (M. D. Anderson Hospital and Tumor Inst., Houston, Tex.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 102: 677-87(Mar. 1968).

A digital computer program (RADCOMP for CDC 1604 or IBM 7094) is described that was developed to calculate γ dose distributions around interstitial and intracavitary radiation sources. The method has been in routine use for more than 3 years at The University of Texas M. D. Anderson Hospital and Tumor Institute at Houston. The features of the program and its clinical application are considered, in addition to the relation between computer dosimetry and the Paterson-Parker system. (auth) (TSS)

36287 STUDIES ON RADIOACTIVE CONTAMINATION OF THE ATMOSPHERE, SOIL, AND AGRICULTURAL PRODUCTS IN KOREA. Bai, D. H.; Lee, S. C.; Han, C. L. J. Nucl. Sci. (Seoul), 7: 56-64(Oct. 1967). (In Korean).

Investigations of radioactive contamination of atmosphere, soil and agricultural products in Korea have been conducted during 1961 to 1966. The results indicate that the atmosphere and biosphere are not yet dangerously contaminated by radioactive fallout and there is very little possibility of affecting plants and animal and human life. (auth)

36288 STUDIES OF THE ^{90}Sr WASH-OUT IN SOIL. Reissig, Herbert (Technische Hochschule, Dresden). Chem. Erde, 25: 204-29(1966). (In German).

The uptake, distribution, and migration of ^{90}Sr, as reflected by literature sources are described. A mathematical model of ^{90}Sr washout constructed from results of lysimeter measurements made from 1959 to 1965 demonstrated good agreement with the migration of ^{90}Sr in soils of average or greater than average cation exchange capacity. Variations observed in soils with small cation exchange capacities were due probably to rapid flow through which limited the exchange effect of the ^{90}Sr ions with the soil sorption complex. There was a slight negative relation between the cation exchange capacities of the soils and the ^{90}Sr migration rates. The ^{90}Sr distribution in a contaminated study section, and the ^{90}Sr fallout in several vertical profiles from soil samples obtained in June 1964 from cropland, grassland, and desert land are discussed. In general, the studies all showed that in most soils the ^{90}Sr migration rate was less than 1 cm/700 mm of precipitate. Because of this it did not seem that any significant washout of ^{90}Sr from the upper soil layers would take place over time interval of 20 or 30 yr. (BBB)

36289 LABORATORY HANDBOOK OF TOXIC AGENTS. Gray, C. H. (ed.). London, Royal Institute of Chemistry, 1966. 190p. £1. 4s.

The handbook consists of five chapters each written by a specialist on the subject. Chapter I: Introduction and principles (hazards and examples of toxic action); Chapter II: Precautions and preventions (laboratory planning, laboratory safety officer, general and special precautions); Chapter III: First aid in the laboratory (emetics, artificial respiration); Chapter IV: Poisonous and corrosive gases, reagents and solvents (this chapter covers 128 pages and lists hazardous substances alphabetically together with precise data on acute and chronic effects and first aid measures); Chapter V: Precautions against radiations (types of radiation, quantities and units, effects and permissible doses of radiation, administrative arrangements for safety, laboratory organization, precautions in work with x rays and sealed sources and unsealed sources. (Occup. Safety and Health Abstr.)

36290 INFLUENCE OF FIELD SIZE, FIELD SHAPE, AND SOURCE-TO-SKIN DISTANCE UPON THE DOSE RATE IN FIXED FIELD TELECOBALT THERAPY. Anttila, Pentti; Spring, Erik (Univ. Central Hospital, Helsinki). Strahlentherapie, 135: 181-5(Feb. 1968).

A study was made of the influence of field size, field shape, and source-to-skin distance upon the dose rate at the maximum point, 5 mm below the surface, of the depth dose curve for rectangular fields. The measurements were made with a Gammatron

1, provided with a cobalt source 1.5 cm in diameter and block diaphragm, and a Gammatron 3 with a 2 cm source diameter and a double focusing collimator, used with and without an additional penumbra trimmer. (auth)

Medicine

Refer also to abstracts 35998, 36185, 36187, 36196, 36206, 36263, 36264, 36284, 36286, 36354, 36361–36363, 36372, 36381, 36382, and 36395.

36291 THE WHOLE-BODY ^{85}Sr SCAN FOR SYSTEMATIC INVESTIGATIONS AFTER SKELETAL METASTAS (RESULTS FROM 82 PATIENTS). Kutzner, J. (Univ., Zurich). Fortschr. Geb. Roentgenstr. Nuklearmed., 108: 89-94(Jan. 1968). (In German).

Total body scanning with ^{85}Sr is a new method of searching for osseous metastases in patients with tumors. Investigations of 82 patients showed that this method was definitely superior to radiological examination of the skeleton. Only about half the metastases demonstrated by ^{85}Sr could be shown radiologically. Radiostrontium was evidently better than radiological examination in the early diagnosis of skeletal metastases. (auth)

36292 COMPLEX INVESTIGATION OF SALIVARY GLANDS BY MEANS OF RADIOACTIVE ISOTOPES AND X RADIATION. Lindenbraten, L. D.; Judin, L. A. (Moscow Medical Inst.). Fortschr. Geb. Roentgenstr. Nuklearmed., 108: 23-32(Jan. 1968). (In German).

A complex method for investigating the salivary glands, using radioactive isotopes and x rays was described. The position, shape and size of the salivary glands and their relationship to tumors in their proximity could be demonstrated by means of x rays, including sialograms with tomography, but also by means of scintigrams using Pertechnat sodium (^{99m}Tc). Scanning gave some information on functional structure. Radio-sialography, using ^{131}I or ^{99m}Tc, indicated the concentrating and excretory ability of these glands and provided quantitative information as to their function. Radiometric examination of the saliva obtained from individual salivary glands after the administration of ^{131}I, indicated the excretory ability of these glands; the examination could be carried out after food had been given. Sialography, which could be combined with tomography in special cases, provided information on the morphology and function of the salivary ducts. The morphology and function of the salivary glands as revealed by complex radiological investigations in normal and in various inflammatory, dystrophic and neoplastic conditions were described. (auth)

36293 DIFFERENTIAL DIAGNOSIS OF URINE FLOW DISTURBANCE BY ISOTOPE NEPHROGRAMS. SHORT-TIME SITTING FOR DISTINGUISHING BETWEEN FUNCTIONAL AND MECHANICAL FLOW DISTURBANCES. Ball, F. (Univ., Mainz). Fortschr. Geb. Roentgenstr. Nuklearmed., 108: 33-9(Jan. 1968). (In German).

The isotope nephrogram was used for continuous observation of urine flow from the kidneys. If the patient was examined in the supine position, there was frequently some functional delay in urine flow which could be differentiated from mechanical obstruction only with difficulty. Observation of the orthostatic reaction of the renal pelvis was a valuable feature in the differentiation between functional and mechanical obstruction, as shown on the isotope nephrogram. This consisted of contraction of the renal pelvis when the patient was erect and resulted in rapid emptying of the renal pelvis, if due to functional obstruction. In the absence of such a reaction, there was either mechanical obstruction or serious damage to the structure of the renal pelvis. Less common conditions associated with reduction in urine excretion (e.g. severe, acute glomerulonephritis) also led to delay in emptying in the isotope nephrogram, which could not be influenced by a change in position. (auth)

36294 FLEXIBLE SCINTILLATION PROBE FOR CARDIAC OUTPUT DETERMINATION. Eichling, John O. (Washington Univ., St. Louis); Goldring, David; Hernandez, Antonio Jr.; Carlson, Erik; Ter-Pogossian, Michel M. J. Nucl. Med., 8: 871-8 (Dec. 1967).

A flexible esophageal scintillation probe was a useful instrument for the determination of the cardiac output in patients following the injection of ^{99}Tc-labeled serum albumin. The probe was easy to introduce into the esophagus of an adult or of a child older than about 5 to 6 years. (auth)

36295 EVALUATION OF ERRORS IN METHODS OF DETERMINING THE SIZE OF THE HUMAN THYROID. Colosimo, M.; Trinci, M. (Univ., Rome). Nunt. Radiol., 33: 41-56(Jan. 1967). (In Italian).

Various radiographic and radioisotope procedures employed for the determination of the thyroid mass are illustrated. The incidence of error is evaluated for each. The causes for discrepancies between planimetric values obtained by scanning and values derived from determinations carried out on surgically removed thyroid glands and on phantoms are discussed. The error resulting from lack of accurate measurement of the focal distance of the collimator is emphasized. The effects of the ^{131}I concentration in the thyroid on the relation between the size of the phantom and that of the scintigram are evaluated. (H.L.W.)

36296 DESIGN AND USE OF A LINEAR SCANNER. Alfrey, Clarence P. Jr.; Cook, Vernice; Pittman, Jeannette P. (Veterans Administration Hospital, Houston, Tex. Baylor Univ., Houston, Tex.). J. Nucl. Med., 8: 859-70(Dec. 1967).

The design and calibration of a scintillation scanning device for measurement of the distribution of radioactivity along the head-toe axis of man is described. This device was used to determine the linear distribution of ^{59}Fe in man; to determine the percentage of radioactivity in any cross segment of the body, and to measure the total-body radioactivity following the injection of ^{59}Fe. Examples of each of these applications are presented. (auth)

36297 NEW AUTOFLUOROSCOPIC CAMERA. Beierwaltes, William H.; Brown, Gordon M.; Jones, Lawrence W.; Thomas, F. Deaver (Univ. of Michigan, Ann Arbor. Bendix Aerospace Systems Div., Ann Arbor, Mich.). J. Nucl. Med., 8: 847-58(Dec. 1967).

Design features of an autofluroscopic camera that may be used for clinical radioisotope scanning are described. The camera system consisted of a NaI crystal to convert γ rays to visible light quanta that are then focused by a lens onto the photocathode of a 3-stage image intensifier that amplifies the light from each scintillation pulse in the NaI crystal to a level where it can be recorded on film. Both pinhole and multichannel collimators could be used with the camera. Preliminary tests in phantoms, using ^{99}Tc or ^{125}I as the source, indicated that the camera has possibilities for use in nuclear medicine. (C.H.)

36298 IMPROVED METHOD OF RENOGRAPHY USING THE SPLIT CRYSTAL SCINTILLATION CAMERA. Harbert, John C.; Ashburn, William L.; Davidson, Jack D. (Dept. of Health, Education, and Welfare, Bethesda, Md.). J. Urol., 99: 681-7(June 1968).

A new technique for obtaining renograms using the scintillation camera is described. The advantages over the dual probe renogram are: Simultaneous renogram curves and sequential images of the anatomic distribution of the tracer are obtained. Small changes in patient position are tolerated. Collimation effectively maintains minimum renal crosstalk uniform over a moderately wide area of the crystal field. Interruption of the test to note the effects of urination or position is easily accomplished. Reproducibility is assured by the ability to locate the detector in a consistent relationship to the kidney. (auth)

36299 CLINICAL APPROACH TO NEUTRON THERAPY. Easson, E. C. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). pp 175-206 of Current Topics in Radiation Research, Vol. III. Ebert, Michael; Howard, Alma (eds.). New York, John Wiley and Sons Inc., 1967.

The possibility of developing a practical therapeutic source of neutrons in an effort to overcome the relative radioresistance of hypoxic tumor areas is discussed. A review of the literature relevant to this problem is also presented. A reliable, compact, and mobile source of neutrons with a deuterium-tritium (D-T) generator is evaluated. (59 references). (M.M.B.)

36300 REACTIVATION IN UV-INACTIVATED E. COLI K_{12} BY CELL-FREE EXTRACTS. Korgaonkar, K. S.; Raut, S. L. (Indian Cancer Research Center, Bombay). Curr. Mod. Biol., 1: 291-8(Nov. 1967).

It was shown that uv-inactivated Escherichia coli K_{12} streptomycin-sensitive cells regain their reproducing ability when treated with the total cell-free extract of the nonirradiated cells from the isogenic stock. This activity was not acquired quickly but required an optimal time interval of 30 min after addition of extract of the irradiated cell suspension in a nonnutritive medium. Incubation during this period was also necessary. This activity did not require light. The reactivating ability seemed also to depend on the nature and extent of contact between the cells and constituents of the extract, since the same extract was active when it was spread on agar plates along with irradiated cells. Most of this activity shown by cell-free extract is carried by its nucleoprotein (NP) fraction. This phenomenon was not due to self recovery during delay in plating or growth promoting action of these extracts, unrelated to uv inactivation, indicating that it is a genuine reactivation effect to be attributed to the NP fraction. Experiments with the streptomycin-resistant cells showed that the extracts need not

be from the same stock of cells and even isologous cells show the reactivating ability. However, such a recovery may not be accompanied by the transfer of the specific genetic marker used. Activity of the NP fraction was completely lost after its treatment with DNase or RNase, but the total nucleic acid or its separate DNA and RNA components obtained from the active NP fraction did not show this activity. (BBB)

36301 CONCERNING THE NOMENCLATURE OF INJURIES CAUSED BY ULTRA-HIGH-FREQUENCY ELECTROMAGNETIC WAVES. Kolesnik, F. A.; Malyshev, V. M. Voenno-Med. Zh., No. 2, 27-8(1967). (In Russian).

The terminology used by various researchers to describe SHF- and UHF-induced symptoms is reviewed. It was concluded that pathological descriptors of such injuries should be generalized as acute and chronic. The degree of injury should likewise be classified from minor to serious. Minor SHF and UHF injuries (chronic or acute) were considered as temporary functional disruptions of the nervous and cardiovascular systems or the blood that did not require prolonged treatment or lower the working capacity of the afflicted. Moderate injuries included persistent functional disruptions that required prolonged or repeated treatment, thus lowering working capacity. Serious injuries should be classified as those that involved organic damage to one system or another and incomplete recovery. Injuries in this category required special work compensations. (ATD)

36302 EFFECT OF TRIIODOTHYRONINE ON THE GROWTH AND RADIOSENSITIVITY OF TUMORS IN MICE. Shima, Takayoshi (Tottori Univ., Japan). Yonago Acta Med., 11: 117-22(1967).

To evaluate the possibility of increasing the effectiveness of radiotherapy by use of thyroid hormone, the effects of l-triiodothyronine (T_3) on the growth and radiosensitivity of tumors in mice were studied. The mitotic rate of Ehrlich ascites carcinoma cells in mice was increased by injection of T_3 in doses of 2, 5, and 10 μg per mouse. The growth rate of spontaneously occurring mammary tumors transplanted in C_3H mice was decreased by daily injections of 2 μg of T_3 for 7 days, and a similar result was obtained with Ehrlich carcinoma in dd strain mice. The reduced rate of mitosis of Ehrlich ascites carcinoma cells in mice caused by whole-body x irradiation with 100 R was enhanced and prolonged by daily injections of 5 μg of T_3 starting two days before irradiation. Growth of spontaneously occurring mammary tumors when transplanted and of Ehrlich carcinoma was markedly suppressed by daily injections of 2 to 5 μg of T_3 starting three days before x irradiation with 2000 R as compared with x irradiation alone. These results suggest that l-triiodothyronine can be used as a radiosensitizer in the radiation therapy of malignant tumors. However, in nonirradiated tumors the growth rate may be slightly increased by T_3. (BBB)

36303 EFFECT OF COBALT PREPARATIONS ON HEALING SKIN WOUNDS OF IRRADIATED ANIMALS. Seyfullin, F. Kh. (Uzbek Scientific Research Inst. of Roentgenology, Radiology, and Oncology, USSR). Med. Zh. Uzbek., No. 10, 34-5(1966). (In Russian).

The results of a study of the role of complex cobalt compounds with the amide of nicotinic acid (coamide or niacin) and with Vitamin B_1 (Co-8 or thiamine), Vitamin H_1 (biotin or Co-9), and Co-30 (Vitamin B_{12}) on the processes of skin regeneration and regeneration of the subcutaneous tissue in white rats are presented. There were three series of experiments. In the first, the control group of 20 animals received only the slash with a razor blade; in the second, which was also a control, 30 rats received general irradiation with x rays and then the wound; and in the third, 120 animals received irradiation and the injury combined, and then were given the preparations being studied. The radiation dose was 800 R. The peripheral blood of the animals was analyzed before the beginning of the experiment and every five days until the end of the experiment. The edges of the wound did not part in any of the animals. In the irradiated control rats edema, infiltration of the tissue, and the presence over the wound of a black scab of varying size were noted. In the healthy, unirradiated animals the wound healed in 10.3 days on the average. The average for the control series of irradiated animals was 17.2 days. In the group of treated animals the skin and subcutaneous tissue healed much faster than in the irradiated control animals. In most cases necrotic elements pulled away from the wound within five days after the operation. Niacin and Co-30 gave the best results of the preparations used. The wounds healed fully in the rats of this series after 10.2 and 10.6 days on the average, respectively, and they healed after 11.2 and 12.6 days for thiamine and biotin, respectively. (JPRS)

36304 EXPERIMENTAL STUDIES ON CHEMICAL PROTECTION AGAINST IONIZING RADIATION. Zebro, Tadeusz (Academy of Medicine, Krakow). Folia Med. Cracov., 8: 149-87(1966). (In Polish).

Sodium cysteinethiosulfonate (CTS) was shown to exert a protective effect in acute postradiation damage of the intestinal mucosa and kidneys, as studied histologically in mice subjected to irradiation with 500 R of x rays. In the alimentary tract, one to five days after irradiation, lesions were observed in untreated controls. On the eighth day after irradiation the lesions in the intestines were less severe. In contrast to earlier findings, marked intestinal lesions were observed 15 to 20 days after irradiation, consisting of degeneration and necrosis of glandular epithelium. Evidently, after initial temporary regression on the eighth day, two weeks after irradiation, an exacerbation of the postradiation changes occurred. These lesions could be the cause of bacteremia, from intestinal microorganisms and could be responsible for increased mortality of the animals at this time. In animals treated with CTS before irradiation, the observed lesions were less extensive and less pronounced. In the kidneys, degenerative and necrotic lesions were observed between the third and eighth days after irradiation in the epithelium of the renal tubules only in irradiated mice not protected by CTS. Thus CTS protected the intestinal mucosa and kidneys against radiation damage. The effect of CTS and aminoethylisothiourea (AET) on the damage caused by irradiation in two transplantable tumors (renal carcinoma and uterine sarcoma) was studied in rats after local irradiation of the tumors. In the renal carcinoma both AET and CTS diminished the damage in the tumor, AET more so than CTS. Their protective effect in irradiated uterine sarcoma was different. AET exerted a protective action, while CTS did not, indicating that different types of tumors react differently to protective substances. By irradiation of tumor tissue under different conditions of oxygenation with simultaneous administration of protective compounds before irradiation some indirect evidence for a mechanism of the action of these compounds was obtained. (BBB)

36305 LATE EFFECTS OF THOROTRAST IN MAN. Reiner, M.; de Siebenthal, J.; Weyneth, R. Helv. Med. Acta, 34: Suppl. 47, 108(May 1967). (In French).

Thorotrast (colloidal suspension of thorium dioxide) was used on a large scale as a contrast agent between 1928 and 1945. Its radioopaque properties and its high short-term tolerance led to its frequent use by radiologists, even though the potential dangers, linked with its radioactivity and retention in the body, were known for a long time. The half-life of Th is about 14,000 yr and, despite low radioactivity, its presence in the body constitutes a permanent and hazardous radiation source. Illustrations were given of different pathogenic effects, especially oncogenesis as observed in recent clinical observations. In one case of Thorotrast arteriography, fibrous contraction of the spleen and hepatic cirrhosis developed after 21 yr, and the patient died of intrahepatic cholangiocarcinoma. From 24 to 27 yr after Thorotrast pyelography in urology, tumors occurred in the immediate area where Thorotrast was used, because of pyelorenal and pyelovenous reflux. Several other cases were also reviewed. (BBB)

36306 APPRAISAL OF THE APPLICATION OF ^{99m}Tc IN THE ASSESSMENT OF GASTRIC FUNCTION. Irvine, W. J.; Stewart, A. G.; McLoughlin, G. P.; Tothill, P. (Royal Infirmary, Edinburgh). Lancet, 2: 648-53(Sept. 23, 1967).

An evaluation was made of the use of ^{99m}Tc in the assessment of gastric function with particular reference to atrophic gastritis in developing a satisfactory test of gastric function without the necessity for intubation. A tracer dose of up to 500 μCi ^{99m}Tc-pertechnetate was given intravenously at the beginning of the basal collection of gastric juice in an otherwise standard augmented histamine test. One-ml aliquots of each sample of gastric aspirate were counted in a well-type scintillation counter. In 19 subjects the secretion of ^{99m}Tc into gastric juice was shown to correlate closely with the volume of the gastric secretion and to a lesser extent with acid content and with the intrinsic-factor secretion during the posthistamine hour. The isotope was also secreted in saliva. The mean gastric uptake of the ^{99m}Tc, as determined by scanning in the absence of stimulation or aspiration of gastric juice, was low in patients with achlorhydria compared with those capable of secreting acid, but the overlap in results for individual patients precluded gastric scanning at one hr as a useful test for gastric function. Alternative procedures were suggested which could lead to ^{99m}Tc studies providing a quantitative index of gastric function without intubation and which would be suitable for clinical use. Unless continuous aspiration was done, an unknown amount of the gastric juice could be lost from the stomach via the duodenum, and swallowed saliva could add significantly to the radioactivity recorded over the stomach area or in the gastric aspirate. If it was accepted that gastric aspiration was required, it was clear that ^{99m}Tc scans would pro-

vide no more information than simply recording the volume of the aspirate. (BBB)

36307 THE ROLE OF THE DIGITAL COMPUTER IN NUCLEAR MEDICINE. Brown, Donald W.; Groome, David S. (Univ. of Colorado, Denver). J. Amer. Med. Ass., 203: 131-7(Jan. 8, 1968). (COO-1472-15).

In nuclear medicine the digital computer is expected to become very useful in the education of residents and technicians, in the coding, searching, and delivery of clinical reports of isotope procedures, and in the keeping and constant updating of an inventory of all the isotopes stocked in the laboratory. The value of most of the function studies carried out in the isotope laboratory can also be improved by the application of modern statistical methods and numerical analysis, and greater objectivity and reliability can be brought to radioisotope scanning. A systems analysis approach to the conduct of the entire laboratory is also being investigated. (auth)

36308 DETECTION OF BONE LESIONS WITH THE ^{85}Sr SCINTISCAN. De Nardo, Gerald (Veterans Administration Hospital, Stanford, Calif.). Med. Bull. U. S. Army, Eur., 24: 261-8(July 1967).

Correct interpretation of the bone scintiscan required knowledge of the normal sites of increased ^{85}Sr concentration. There was increased radioactivity normally at the ends of the long bones, around the acetabula and sacroiliac joints, over the vertebrae, carpal and tarsal bones. These sites of increased radioactivity were present in adults and children, although they were more prominent in the latter. Comparison of symmetrical areas of the skeleton or of vertebrae above and below the suspicious area assisted in interpretation. If the pelvis or lumbar vertebrae were to be scanned, the bladder, rectum, and colon were evacuated because ^{85}Sr was excreted in the urine and feces. The bone scintiscan was technically difficult to perform and too time consuming for screening purposes. The abnormalities demonstrated were frequently nonspecific. Scintiscanning depended upon uneven bone involvement and was poorly suited to the evaluation of uniform metabolic bone disease. A whole-body profile scanner used for screening consists of four scintillization detectors which moved as a unit; two above and two below a table upon which the patient reclined. The patient received ^{85}Sr and was subsequently scanned from head to toe. A count rate profile was recorded and an area of increased ^{85}Sr concentration could be lateralized and its depth determined. The procedure required only a few minutes. If there was asymmetry of ^{85}Sr concentration, the particular area was studied in detail with the standard scanner. (BBB)

36309 RADIOACTIVE ISOTOPES. THEIR GENERAL BIOLOGICAL AND MEDICAL APPLICATIONS. van der Werff, J. Th. Eindhoven, Netherlands, Centrex Publishing Co., 1966. 133p. $5.00.

Translated from the Dutch by C. J. Mantle.

Applications of radioisotopes in biological and medical studies are discussed. Fundamental physical concepts of nuclear reactions and the production and characteristic properties of radioisotopes are reviewed. The dosimetry of ionizing radiations, the sensitivity of various radiation detectors, and scanning techniques are discussed. The biological effects of radiation and principles of radiation protection are summarized. Specific directions are included for the use of radioisotopes in diagnostic medicine. Although the book was intended as a textbook for medical technicians using radioisotopes, much of the text is applicable to all radioisotope laboratories. (C.H.)

36310 CONFORMATION RADIOTHERAPY BY MEANS OF 6-MeV LINEAR ACCELERATOR. Kitabatake, Takashi; Takahashi, Shinji (Nagoya Univ., Japan). Tohoku J. Exp. Med., 94: 37-43(Jan. 1968).

The operation of and dose calibration for a 6-MeV linear accelerator are described. Dose distributions for this machine are compared with those for ^{60}Co teletherapy units. In this machine the collimator is divided into 6 leaves which are driven independently by a servo system following signals given by the signal generator. The mechanical error in this system is within a range of +1.47 to −1.80%. The size and shape of radiation-dense area (beam focus) with this unit coincided geometrically with the region of planned treatments. When the telecobalt conformation technique was applied to cervical cancer, the region of treatment estimated by geometrical determination in planning for irradiation occupied only about 87% of the area encircled by the isodose curve actually obtained, in contrast to 93% with the linear accelerator x rays. Therefore, 6-MeV x rays from the linear accelerator distributed dose more homogeneously in the treatment area as compared with the dose distribution of telecobalt γ rays. (BBB)

36311 RADIOSENSITIVITY AND VIRULENCE FACTORS IN CERVICAL CANCER: INDIVIDUALIZATION OF TREATMENT. Gusberg, S. B.; Herman, Grace G. (Mt. Sinai School of Medicine, New York). Amer. J. Obstet. Gynecol., 100: 627-39(Mar. 1, 1968).

Use of a radiosensitivity test program to determine the optimal treatment of cervical cancer was outlined, and radiobiologic bases and criteria of tumor cell radioresponse were discussed. Several biologic characteristics were utilized in making the choice of treatment by radiotherapy or surgery. A test dose of radiation made it possible to discriminate between good responders in Stages I and II with an expected relative cure rate of 72.1% and those with poor response whose relative cure rate declined to 32.5% under the same radiotherapeutic treatment. Another group with poor response subjected to radical surgery achieved a relative cure rate of 56%. Tumor virulence was also assayed by recording lymphatic invasion in the control biopsies. The validity of age and geographic tumor configuration as measures of tumor virulence were not established. A protocol of individualized treatment for cervix cancer based on these considerations is presented. (BBB)

36312 REGIONAL OXYGENATION AND ITS EFFECT UPON RADIATION THERAPY AND ISOTOPE LOCALIZATION. Mallams, John T.; Finney, J. W.; Balla, G. A. (Baylor Univ., Dallas). pp 686-95 of Proc. Third Intern. Congr. Hyperbaric Medicine, Duke Univ., Durham, N. C., Nov. 17-20, 1965. Washington, D. C., National Academy of Sciences, 1966.

Because of significant differences between the vascular anatomy of most animals and that of humans, animal values are not comparable to human values and thus cannot be used as guidelines for dosage. Full 100% normal protracted daily doses of radiation were used in conjunction with H_2O_2 infusion. The only parameters of tolerance in normal tissue were early skin and mucous membrane reactions and late evidence of fibrosis, osteitis, and necrosis. To date, there was no significant decrease in tolerance of normal tissue with this system, and no late complications have occurred. Infusion of H_2O_2 solutions can cause severe vessel spasms and bubbling, resulting in mechanical vessel obstruction. In addition, all of the common complications encountered with insertion of catheters are experienced on occasion, such as infection or clot formation. With careful individualization and well-controlled experienced care, all significant complications are virtually eliminated. (BBB)

36313 BLOCKING OF THE THYROID GLAND FOR CEREBRAL SCINTIGRAPHY. Hirschbiegel, Horst (Univ., Duesseldorf). Strahlentherapie, 135: 295-300(Mar. 1968). (In German).

Experience with 88 patients showed that potassium-perchlorate was the most effective of all thyreo-inhibitors for blocking the thyroid gland before a cerebral scintiscanning with ^{131}I. Almost no failure nor side-effects were observed. Further measurements in 32 patients during four weeks showed that 1200 mg of perchlorate daily before the injection of serumalbumin was insufficient for protecting the thyroid from radiations. It seemed that continuous administration of perchlorate for three weeks should be advised during and after radiodiagnosis of the brain. (auth)

36314 STUDIES ON THE SIGNIFICANCE OF TAURINE IN RADIATION INJURY. Abe, Mitsuyuki; Takahashi, Masaji; Takeuchi, Katsumi; Fukuda, Masasi (Kyoto Univ.). Radiat. Res., 33: 563-73(1968).

The changes in the urinary excretion of taurine were shown in mice irradiated with a dose producing 80% mortality. The greatest increase in taurine occurred on the first day after irradiation. Thereafter taurine content fell rapidly. During the fourth through the ninth day after exposure, the taurine level in the urine remained lower than the normal amount. From the tenth postexposure day, the level again increased markedly. This elevated excretion ran almost parallel with the increase in the daily mortality rate (based on the fraction of the survivors that die during a given day) of irradiated mice. Various doses of taurine were given to mice at various times after irradiation. The therapeutic effect of taurine in the sense of an increase in the fraction of mice surviving for 30 days postexposure was observed when it was given from the second postirradiation day. The effect was pronounced when it was given on the fourth day after irradiation, at which time the amount of taurine in the urine reached its minimum level. It was also demonstrated that the administration of taurine to irradiated mice promoted the recovery of leukocytes. (auth)

36315 EFFECTS OF COMBINED USE OF CYCLOPHOSPHAMIDE (ENDOXAN) AND IONIZING RADIATION ON PROLIFERATION PROCESSES OF NORMAL TISSUES. HISTOLOGICAL AND AUTORADIOGRAPHIC INVESTIGATIONS WITH ^{3}H-THYMIDINE ON THE EPITHELIUM OF THE TONGUE AND

ON THE SMALL INTESTINE OF MICE. PART II. Schuster, Reinhold (Univ., Goettingen, Ger.). Strahlentherapie, 135: 320-36(Mar. 1968). (In German).

Using ^{3}H-thymidine autoradiographic techniques, the effect of a combined use of ionizing radiation and cyclophosphamid (Endoxan) upon DNA-synthesis was investigated in small intestine and tongue epithelium of inbred white male mice. The temporal course of the autoradiographic results was compared with that of morphological changes in cells and nuclei at different times (up to 96 hours) after irradiation. Irradiation alone (200 rad whole or partial body irradiation) as well as administration of Endoxan alone could cause changes in ^{3}H-thymidine incorporation, which pointed to an influence in the G_1-phase as well as in the synthesis phase. The combined use of ionizing radiation and Endoxan resulted in a delayed disappearance of autoradiographically noticeable changes as well as of the morphological changes. In the beginning, the number of cells which were able to incorporate ^{3}H-thymidine was greatly reduced as a result of an influence upon the G_1-phase; later on, after high (80 mg/kg body weight) and sublethal (200 mg/kg body weight) Endoxan doses, an additional inhibition of ^{3}H-thymidine incorporation into those cells which were in DNA-synthesis, was observed. The extent and the course of the change in the tissues investigated showed considerable differences; irradiation followed immediately by Endoxan administration showed the greatest influence upon the extent and course of the changes. (auth)

36316 SEQUENCE OF HISTOPATHOLOGIC EVENTS IN THE RAT BOWEL AFTER LOCALIZED X-IRRADIATION AND URETHAN. Zaldivar, Robert (Univ. of Rochester, N. Y.). Contract W-7401-eng-49. Strahlentherapie, 135: 241-9(Feb. 1968).

The sequence of histopathologic events from three days to periods over a year in the exteriorized segment of the small intestine in 226 male albino rats following various single doses of x rays (0, 600, 1000 or 1400 R) and urethan (1 mg/g body weight) in terms of the two stage mechanism hypothesis was studied. Animals with a segment exposed to 1000 or 1400 R exhibited prominent gross and histopathologic changes. The intestinal mucosa, especially in rats irradiated at 1400 R, had necrosis and ulceration and regenerating crypts with a marked increase in the number of goblet cells. Vascular changes included mainly increased thickness of the wall as well as severe restriction in the lumen's diameter. Epithelial lesions showed regression at 373 to 425 days post-exposure, except a residual damage consisting of sclerosis of small arteries and arterioles. Urethan induced no tumor, neither was any influence observed on the reaction of the bowel mucosa to localized x irradiation. (auth)

36317 QUESTION OF THE EFFECTIVENESS OF A THROMBOEMBOLITE PROPHYLAXIS BY MAGNESIUM IN CONTACT THERAPY OF CERVIX OR CORPUS CARCINOMAS OF THE UTERUS WITH GAMMA EMITTERS. Claus, Hans-Dieter (Bergarbeiterkrankenhauses, Erlabrunn/Erzgeb., Ger.). Strahlentherapie, 135: 291-4(Mar. 1968). (In German).

Patients (164) with cervix or corpus uteri carcinoma were treated with intracavitary gamma-emitters; the possibility of prevention of thrombo-embolitic complications by administration of magnesium was studied. The statistical study and comparison of two groups, one without and one with the magnesium showed a significant protective effect of the magnesium up to a P of <0.01. (auth)

36318 RADIOPROTECTIVE EFFECTS OF AET, GLUTATHIONE, AND SEROTONIN IN AN IRRADIATION IN AIR OR NITROGEN ATMOSPHERES OF GRASSHOPPER CHROMOSOMES. Chaudhuri, J. P. (Benares Hindu Univ., Varanasi, India). Strahlentherapie, 135: 250-3(Feb. 1968). (In German).

The effects of AET, glutathione and serotonin pretreatment on the frequency of x-ray induced chromosome aberrations were determined by counting the dicentric bridges and fragments in the meiotic first division anaphase cells of Grasshopper spermatocytes. AET and glutathione pretreatment experiments were also done under anoxic condition and a higher efficacy of AET was noted in anoxia. The synergism of the protection due to AET and that due to anoxia did not suggest radical-scavenging mechanism for the protection of chromosomes. (auth)

36319 TOXIC EFFECTS OF ALLOXAN ADMINISTERED TO IRRADIATED RATS. Sanders, Charles L.; Krise, George M. (Texas A and M Univ., College Station). Int. J. Radiat. Biol., 13: 97-8(1967).

Albino rats (200 to 250 g body-weight) were randomly divided into two groups; half were given sham-irradiation, and the other half were given 500 R whole-body ^{60}Co γ radiation (200 R per hour). Eight rats in each group were given 1 ml physiological saline, and the eight remaining were given 15 mg alloxan per 100 g body-weight dissolved in 1 ml saline. All injections were administered intraperitoneally, immediately after irradiation. Each rat was bled after a 24-hour fast, and 1 ml of blood was mixed with EDTA and analyzed for glucose content. The blood glucose levels of rats given irradiation and saline were not significantly different from those of rats given sham-irradiation and saline. Glucose levels of the sham-irradiated animals given alloxan increased at the first hour and then fell to below normal levels during the succeeding 35 days. In irradiated rats given alloxan there was an almost linear increase of blood glucose with time during the 35-day observation period; glucose values in this group were significantly higher than values found in all other treatment groups after the 14th day. Animals given irradiation and alloxan lost an average of 67 g body-weight after 35 days, as compared to a gain in body-weight of 88 g in those given sham-irradiation and saline, a gain of 61 g in those given irradiation and saline, and a gain of 104 grams in those given sham-irradiation and alloxan. Four of eight rats given irradiation and alloxan died between 21 and 35 days following treatment. The remaining four died by the 51st day. No mortality was observed in any other experimental or control groups during this 51-day observation period. Results indicated that alloxan was very toxic to irradiated rats. (C.H.)

36320 LINEAR SCANNING IN THE STUDY OF LUNG CANCER. Bagliani, G.; Roncoroni, L. (Univ., Milan. Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Med. Nucl. Radiobiol. Lat., 10: 105-17(1967). (In Italian).

In lung scintigraphy with ^{131}I-labeled macroaggregated albumin (MAA-^{131}I) radioactive micells are arrested in the small circuit arteriocapillary vessels. The arresting of MAA-^{131}I is only temporary. After a certain time the macroaggregates disperse and succeed in passing the capillary filter. In order to evaluate the blood flow in the lungs, the lung area must be rapidly examined in such a way that the withdrawal of radioactivity from the lung is negligible during the execution of the study. Scintigraphy is unsuited to this end being a slow examination method. Linear scanning of the chest allows rapid exploration of both lung areas and as it can be executed with very simple equipment is valuable in studying distribution of MAA-^{131}I in the lungs. Results are shown of linear scanning of normal chests and of a group of 25 cases of lung cancer. (auth)

36321 CLINICAL USE OF RADIOIODINATED TRIOLEIN IN FUNCTIONAL STUDY OF MELLITUS DIABETES. Riccardi, A.; Bergonzi, M.; Sanvito, R. (Univ., Milan). Med. Nucl. Radiobiol. Lat., 10: 143-52(1967). (In Italian).

Oral administration of 50 μCi of triolein-^{131}I to a group of diabetic patients showed elimination of radioactivity in feces similar to that in normal control subjects, a normal curve of radioactivity content in plasma and a lesser urinary elimination of radioiodine. These findings can be attributed to alteration of hydro-saline metabolism in earlier stages than those in which renal insufficiency might be clinically shown. The possibility and limits of the methods are discussed. (auth)

36322 CORRELATION BETWEEN RADIOEPHROGRAPHIC EXAMINATION AND ANATOMO-PATHOLOGICAL FINDINGS IN 15 CASES OF CHRONIC PYELONEPHRITIS. Puricelli, G.; De Petra, V.; Signorelli, E. Med. Nucl. Radiobiol. Lat., 10: 153-71(1967). (In Italian).

Fifteen cases of chronic pyelonephritis (6 primitive and 9 secondary to urological damage) were studied, comparing histological with radionephrographic findings. It was found that radionephrographic curves rarely permitted establishing whether the diseases was primitive or secondary and also failed to establish definite pathognomic nephrographic findings in diagnosis of chronic pyelonephritis. The examination was used to determine whether the renal disease is mono or bilateral, to evaluate the actual residual function of each kidney, and to relate diseases to histological and renographic parameters. The radionephrogram, from the point of view of sensibility in showing up renal disorder although it falls short of histological examination minuteness is nevertheless generally more sensitive than other traditional methods. (auth)

36323 LIMITS OF DETECTING ABNORMALITIES WITH SCANNING. Pope, R. A. (Royal Melbourne Hospital, Parkville, Australia). Australas. Radiol., 11: 389-94(Nov. 1967).

A theoretical comparison was made between two different criteria of statistical significance for detecting abnormalities in a scan. Criterion I utilizes as much of the available information content as possible, while Criterion II is applicable to visual reading of a photoscan or color scan. The limits of detecting abnormalities with Criterion II is theoretically inferior to that with Criterion I. Using theoretical estimates of contrast for various sized abnormalities, the concentration ratio of $^{99m}TcO_4^-$ in cerebral lesions was estimated from a number of scans. The mean concentration ratio was 6.5, assuming a log-normal distribution. (auth)

36324 AN INVESTIGATION INTO SOME OF THE FACTORS INFLUENCING SCAN QUALITY. Scott, B. W. (Royal Prince Alfred Hospital, Camperdown, Australia). Australas. Radiol., 11: 374-88(Nov. 1967).

An investigation of factors influencing scan quality when radioisotopes emitting γ rays with widely different energies are used as tracers showed that radioisotopes with energy as low as 77 keV may be used without affecting scan quality. This results in a reduced radiation dose to the patient. The radioisotopes used in the study included ^{131}I, ^{197}Hg, ^{203}Hg, and ^{99}Tc, representative of radioisotopes that emit energies in the range of 70 to 400 keV. The measurements were made with collimated scintillation counters on spheres of perspex filled with solutions of the radioisotopes suspended at various depths in a water-filled tank. Data are reported on the spectra of scattered radiation, the effects of energy on contrast, the extent to which the counting rate is attenuated by scattering in water, the relation between adsorbed dose and counting rate, and other factors that affect scan quality. (C.H.)

36325 VARIATIONS IN ^{99m}Tc BRAIN SCANS REPORTED AS NORMAL. Andrews, J. T.; Pope, R. A. (Royal Melbourne Hospital, Victoria, Australia). Australas. Radiol., 11: 395-402(Nov. 1967).

An average number of 50 brain scans were performed during one month. Of these 70% were reported as normal. A survey was made of a series of adult technetium-99m brain scans reported as normal. An attempt was made to assess the variations in the normal pattern. The effect of potassium perchlorate in blocking the uptake of ^{99m}Tc by the thyroid gland and choroid plexus was evaluated. (auth)

36326 A NEW ^{68}Ga-COMPOUND FOR KIDNEY SCANNING. Anghileri, L. J. (Institut fuer Nuklearmedizin, Heidelberg). Int. J. Appl. Radiat. Isotop., 19: 421-22(Apr. 1968).

There is considerable interest in the use of ^{68}Ga in diagnostic scanning. An advantage of this short-lived radioisotope ($t_{\frac{1}{2}}$ = 68 min) is that it may be generator-produced from a long-lived parent ^{68}Ge ($t_{\frac{1}{2}}$ = 280 days). ^{68}Ga decays mainly by positron emission, with associated 0.51 MeV annihilation radiation. Other high energy γ rays emitted amount to only four percent of the γ ray output. A new ^{68}Ga-compound, suitable for kidney scanning, has been developed. This compound, a ^{68}Ga-polymetaphosphate-Mg-polymetaphosphate, showed a preferential deposition in the kidneys of rats. The technique of preparation was described. (auth)

36327 DECREASE OF RADIATION DAMAGE TO CHROMOSOMES BY DNA AND DEOXYRIBONUCLEOTIDES. Smets, L. A.; Hallman, P.; Lause, P.; Kuyper, Ch. M. A. (Univ. of Nijmegen, Netherlands). Int. J. Radiat. Biol., 13: 269-73(1967).

Calf liver cells in culture were exposed to x radiation. Native DNA and equimolar solutions of DNA precursors caused a marked decrease in the yield of radioinduced chromosome aberrations. Deoxyadenylic acid and deoxyguanylic acid proved effective in reducing chromosome damage when added together to the cells. No such effect was afforded by single deoxyribonucleotides or RNA precursors. (C.H.)

36328 DNA REPAIR OF RADIATION DAMAGE. II. HAEMATOLOGICAL STUDIES ON RATS LETHALLY IRRADIATED WITH GAMMA-RAYS. Golba, Stanislaw; Golba, Maria; Wilczok, Tadeusz. Int. J. Radiat. Biol., 13: 261-8(1967).

Treatment by heterologous DNA administered after whole-body irradiation improved survival and accelerated the recovery of body-weight and of the counts of red blood cells, granulocytes, and lymphocytes in the peripheral blood of rats. There was no secondary disease or change in the blood count during the next 12 months (auth)

36329 STUDIES ON RADIATION SENSITIVITY. I. EFFECTS OF CHEMICALS ON U.V.-INACTIVATION OF YEAST SACCHAROMYCES CEREVISIAE 23971. Lee, Min Jai; Hong, Soon-woo; Choih, Sun-jin (Seoul National Univ.). J. Nucl Sci. (Seoul), 7: 11-17(Oct. 1967). (In Korean).

The combined effects of radiation and various chemical reagents on microorganisms were studied. The synergistic activities of reagents to enhance the radiolethality during irradiation were demonstrated with Saccharomyces cerevisiae. Chemicals used are hydrogen peroxide, ferric chloride, ferric sulfate, ferrous sulfate, ferrous chloride, cupric chloride and cupric sulfate. Among the chemicals examined, H_2O_2, $FeCl_3$ and $Fe_2(SO_4)_3$ were most potentiating and such reagents as $FeSO_4$, $FeCl_2$, $CuCl_2$ and $CuSO_4$ showed weak inactivating effects. (auth)

36330 EFFECT OF PANAX GINSENG AGAINST TOTAL BODY X-RAY IRRADIATION ON THE BLOOD PROTEIN. Nam, Sang Yul (Kyung Hee Univ., Seoul). J. Nucl Sci. (Seoul), 7: 1-10(Oct. 1967). (In Korean).

At 40 min, 24 hr, or 4 consecutive days before a dose of 120 R x-irradiation, male mice were given an injection of ginseng extract. A control group received sodium chloride injections. During the 21 days post-irradiation, it was found that a rise in the ratio of serum albumin to globulin and a decrease in total serum protein content occurred in both groups of mice. Two phases of change were found; one beginning the first day and the second beginning about 8 days after irradiation. Ginseng extracts greatly delayed the increase in serum albumin to globulin ratio and the decrease in total serum protein content. Ginseng extract also greatly delayed the decrease in ratio of liver weight to body weight but showed no effect on kidney weight. Comparable protection was obtained when injection occurred at 40 min or 4 consecutive days before irradiation, but injection at 24 hr had no effect. It was concluded that ginseng extract greatly reduced the sensitivity of mice to the effects of x radiation on blood proteins. (CO)

36331 EFFECT OF B VITAMINS ON THE PERIPHERAL BLOOD IN CONNECTION WITH RADIATION SICKNESS. Alimov, R.; Mavlyandzhanov, K. (Uzbek Scientific Research Inst. of Roentgenology, Radiology, and Oncology, Tashkent). Med. Zh. Uzbek., No. 8, 75-7(1966).

The results of investigations of the effects of B vitamins (Co-35: cobalt with organic substances and Co-36: nicotinamide) on the peripheral blood of irradiated animals are reported. The Co-35 accelerated the reestablishment of the number of leukocytes and the hemoglobin content in irradiated mice. Co-36 which affected neither the hemoglobin content nor the number of erythrocytes, considerably increased the number of reticulocytes (by 88.2%) and prevented a reduction in the number of leukocytes in the blood of irradiated animals. Co-36 had almost no effect on leukopoiesis, but it improved the composition of the red corpuscles. Neither preparation had any noticeable effect on body weight or the spleen of irradiated animals. Prolonged administration of Co-35 and Co-36 from the fifth day of irradiation had a positive effect on hematopoiesis. The hemoglobin content rose 28%, the number of erythrocytes 9.9%, and the number of reticulocytes 35%; the number of leukocytes dropped to considerably less than that of the control group. (JPRS) (TSS)

36332 ATTEMPT AT QUANTITATIVE ANALYSIS OF SURFACE SCANNOGRAMS. Setaelae, Kai (Univ. of Helsinki). Strahlentherapie, 135: 213-16(Feb. 1968).

A technique for quantitative determinations on the basis of black-and-white surface scanogram of accreted radioactivity was described. The technique was presented in detail, and its accuracy discussed. The suitability of the measure was illustrated by a case randomly selected from the laboratory's files, using a parasympathicomimeticum, pilocarpine nitrate, as a radioisotope-moving agent in a patient prior to photoscanning of the thyroid and salivary glands. (auth)

36333 ^{203}Hg NEOHYDRIN RENAL SCANNING IN THE DIAGNOSIS OF ADVANCED RENAL DISEASE. Moon, Hyo Joong (Pusan National Univ., Korea). J. Nucl Sci. (Seoul), 7: 169-77 (Oct. 1967). (In Korean).

The results of the ^{203}Hg-neohydrin renal scanning, made on 17 cases of advanced renal disease of which 9 cases were renal tuberculosis, 4 cases renal stone, 2 cases hydronephrosis, 2 cases polycystic kidney and 1 case Wilms' tumor were compared to the findings of intravenous pyelography (I.V.P.) for diagnostic value. It was postulated that renal scanning is superior to I. V. P. for the sake of evaluation of the degree and site of the destruction in conjunction with status of the residual functioning tissue. It was considered better that ^{203}Hg-neohydrin renal scanning and I. V. P. should be done simultaneously for the diagnosis of advanced renal disease. (CO)

36334 EVALUATION AND REDUCTION OF RISKS: A CONCEPT OF LIFETIME TOLERANCE TO RADIATION. Jones, Hardin (Donner Lab., Berkeley, Calif.). Pediatrics, 41: Suppl., 271-7(Jan. 1968).

The inappropriateness of the threshold theory of radiation effect, especially when applied to such phenomena as induction of cancer, cell killing, and life shortening, is discussed. In studies of the incidence of some types of cancer that increases following radiation exposure, the same kind of cancer also occurs at some observable frequency in the control population. Thus, there is always a low level of exposure below which no statistically significant increase in cancer may be proven over controls. Various schemes have been devised to test dose-response relations in the low dose range. Recent estimates of long-term contribution to the genetic burden by irradiation at low dose rates have been revised downward to $\frac{1}{6}$ of the prior estimates, which initially were based solely on high dose rates. It is estimated, on the basis of re-evaluation of the medical follow-up of the Japanese exposed to atomic bomb radiation at Hiroshima and Nagasaki, that the normal

leukemia rate was increased by 1% for each roentgen of exposure. Since the normal rate was about 10^{-4}, the increase due to radiation would be 10^{-6} per roentgen each year. Present acceptance of the nonthreshold concept, which postulates a continuous relation between exposure and risk of life-shortening disease, has resulted in a lowering of the maximum permissible exposure to 1/7 of that which prevailed in the threshold period. (BBB)

36335 INDICATED BIOLOGICAL EFFECT FROM THE 9 JULY 1962 HIGH ALTITUDE NUCLEAR TEST. Levengood, W. C. (Univ. of Michigan, Ann Arbor). Int. J. Biometeorol., 11: 195-99 (July 1967).

The July 9, 1962 nuclear explosion occurred during mating tests in a long-term experimental program for examining reproductive variations in Drosophila melanogaster. Continuous inbred matings were being observed to investigate the influence of various natural environmental parameters on progeny yields. New generations consisting of 6 pairs of flies were being placed in fresh cultures every few days, using parents flies from the preceding generation. By chance some new generations were initiated on the July 9 test date. The critical period in the flies life cycle is the interval showing the greatest sensitivity to changes in environment, that is, the 72 hr covering the day before, the day of, and the day after the initiation of a new culture. The 9 July test occurred at the midpoint (09:00 UT) of this observed 72-hr critical period of apparent environmental sensitivity in the developing zygote. It was noted that a consistent and unusually pronounced decrease in progeny yield occurred in the same generation in 8 separate test cultures. The July 9 matings were in the F_9 of test sequences which were subsequently extended to the F_{15} generation. It is suggested that increased levels of ionized air produced by particle radiation entering the earth's atmosphere may explain this effect on Drosophila reproductive performance. (BBB)

36336 ULTRAVIOLET-INDUCED ACANTHOLYSIS IN FAMILIAL BENIGN CHRONIC PEMPHIGUS: DETECTION OF THE FORME FRUSTE. Cram, David L.; Muller, Sigfrid A.; Winkelmann, R. K. (Mayo Clinic, Rochester, Minn.). Arch. Dermatol., 96: 636-41 (Dec. 1967).

During a study of uv-induced acantholysis in pemphigus, the same experimental method was applied to a patient with familial benign chronic pemphigus (FBCP). With the use of a carbon arc lamp, Corning Glass filters, and a 20-min delayed erythema dose, microscopic acantholysis was induced in the uninvolved skin of the back by the entire uv light spectrum but not by light of the visible spectrum. This prompted the study of a family in which some members had FBCP; the uv test method was used to determine whether microscopic acantholysis might be demonstrated in clinically normal members, thus identifying persons genotypic for the trait but without clinical disease. Each member (29) of the family was subjected to a 20-min irradiation from a carbon arc lamp, uv B-carbons, using the Corning Glass filter (No. 5860) at an arc-to-skin distance of 25 cm. The filter was selected because it transmitted long-wave uv light only, thus producing no visible erythema or subsequent discomfort of irradiated skin. The test areas were biopsied at 24 hr. It was possible to identify clinically normal carriers of the gene. Two members in the family were discovered by means of this phototest method, which appeared not only to identify the clinically normal heterozygote of FBCP but also to be useful in the diagnosis of suspected disease in remission when clinical lesions were not apparent. (BBB)

36337 TUMOR LOCALIZING AGENTS. IV. RADIOIODINATED ANALOGS OF 1,1-DICHLORO-2,2-DI(CHLOROPHENYL)-ETHANE. Counsell, R. E.; Ranade, V. V.; Lala, L. K.; Hong, B. H. J. Med. Chem., 11: 380-2 (Mar. 1968).

There is a clinical need for an agent for photoscanning the adrenal gland and associated tumors. In an attempt to meet this need, several radioiodinated analogs of 1,1-dichloro-2-(o-chlorophenyl)-2-(p-chlorophenyl) ethane (o,p'-DDD) were described in which one of the aromatic chlorines was replaced by radioiodine. The synthesis of these compounds was prompted by the fact that o,p'-DDD is the only effective agent used for the treatment of adrenocortical carcinoma, and apparently exerts its action by concentrating in adrenal tissue. Preliminary animal studies with the radioiodinated compounds indicated that they may be useful for adrenal photoscanning in humans. Preparation of radioiodinated DDD analogs in which the aliphatic chlorines were replaced with radioiodine is described. Radioiodine-labeled compounds were obtained by isotope exchange with $Na^{125}I$ in refluxing acetone or acetonitrile. Isotope exchange, accompanied by elimination and purification of the radioiodinated product, was done by column chromatography. Tissue distribution studies with the radioiodinated compounds were carried out in rats, and tissues were analyzed 4 to 24 hr after intravenous administration. (BBB)

36338 DOUBLE ISOTOPE SCINTIPHOTOGRAPHY FOR DIFFERENTIATING BETWEEN RENAL CYSTS AND RENAL TUMORS. Black, Melvin B.; King, Charles D.; Smith, Donald R. (St. Luke's Hospital, San Francisco). J. Urol., 98: 728-34 (Dec. 1967).

Time-lapse scintiphotography of intravenously injected sodium pertechnetate-^{99m}Tc was combined with conventional chlormerodrin-^{203}Hg renal scintiphotography in development of a technique to differentiate between renal cysts and renal tumors. A dose of 100 to 150 μCi chlormerodrin-^{203}Hg was injected intravenously into the patient. After one hr, a posterior scintiphoto of the kidneys was made, a two-to-five min exposure sufficing to accumulate 15,000 counts. A bolus of 5 to 10 mCi sodium pertechnetate-^{99m}Tc was injected rapidly into an antecubital vein. In 12 to 15 sec (the circulation time) two sequential 20-sec exposures were made with a pho/gamma scintillation camera fitted with a 3-in. multichannel collimator. The first exposure primarily showed filling of the aorta and kidneys as well as early filling of the spleen. The second one showed complete vascular patterns of the kidneys, spleen, and liver. The pertechnetate scintiphotos were superimposed on those taken of chlormerodrin. If the defective area, seen in the latter, showed decreased or absent uptake of pertechnetate, the lesion was considered to be an avascular cyst. If the defective area showed good uptake of pertechnetate, the lesion was considered to be a vascularized neoplasm. (BBB)

36339 THE ^{131}I RENOGRAM IN PREGNANCY. I. SAFETY. Wax, Sandor H.; Rudolph, Jerome H. (Univ. of Rochester, N. Y.). Obstet. Gynecol., 30: 381-5 (Sept. 1967).

Primary consideration must be given to the potential irradiation exposure of the fetus when utilizing radioisotopes during pregnancy. Radiation from radioactive Hippuran was insignificant due to the rapid maternal renal excretion and elimination. Of greater concern was the radiation exposure from the radioactive inorganic I. From 1 μCi of ^{131}I iodide given a pregnant woman the fetal thyroid could receive a theoretical maximum dose of 5 R. If 10 μCi of ^{131}I-labeled Hippuran was administered to a pregnant patient (with the additional assumption that 1 to 5% was free I), the estimated maximum irradiation dose to the fetal thyroid gland is about 0.5 to 2.5 R. Premedicating patients with 200 mg of KI reduced the radioactive uptake of the thyroid gland by 80%. The theoretical maximum exposure to the fetal thyroid following premedication of the mother with Lugol's solution was 0.1 to 0.5 R, depending on the amount of free iodine in the injected sample. The calculated radiation exposure to the fetal gonads from the intravenous pyelography studies would be 0.843 R. The actual amount of irradiation exposure to the nonviable abortuses and term newborns was significantly less than the calculated theoretical dosages. All except one showed minimal or undetectable activity in the fetal thyroid. The highest activity found was 0.1 R in a seven-month-old fetus delivered by cesarean section. The patient was almost completely anuric due to renal failure, and thus could not excrete the Hippuran efficiently; premedication with Lugol's solution was not used prior to the renogram; and the possibility existed that there was more than 5% free I in the test solution. In five patients who were not given Lugol's solution before testing there was no radioactivity in the fetal thyroid gland. However, Lugol's solution should be given as premedication to all patients as an added safety precaution. (BBB)

36340 LOCALIZATION AND EFFICIENCY OF INTERSTITIAL CHROMIC PHOSPHATE IN THE BLADDER. Weaver, Robert G.; Chamberlin, E. Carl; Brown, Blaine R. (Univ. of Utah, Salt Lake City). Trans. Amer. Ass. Genito-Urinary Surg., 58: 168-75 (1966).

Interstitially injected $Cr^{32}PO_4$ for treating grades two and three bladder carcinoma remained localized to the site of injection within the bladder wall. It was easy to handle, safe to administer, and well tolerated by the patient. The radioisotope could be accurately placed within the bladder wall by decreasing its unit dose and increasing the injection volume to an area circumscribed by a plastic ring. The exact dosage per gram was thus controlled. From 25 to 35 μCi/g tissue delivered 6000 to 10,000 R to a selective area, thus giving a very high differential dose. No cold spots were observed with this method. Microradioautographs show that all tissues in the injected area were irradiated from cross-firing of the active particles. The radioisotope must be assayed prior to use and adequately dispersed to ensure that tumoricidal doses of irradiation were placed in the bladder walls. (BBB)

Radiation Effects on Animals

Refer also to abstracts 36180–36183, 36185, 36186, 36195, 36196, 36204, 36206–36210, 36212, 36215, 36219, 36237, 36245, 36247, 36249, 36280, 36281, 36302, 36305, 36312, 36314–36319, 36327,

36328, 36330, 36334, 36335, 36419, 36421, 36423, 36427, and 36428.

36341 (AD-661795) ULTRASTRUCTURAL STUDIES OF X-RAY INDUCED GLOMERULOSCLEROSIS IN RATS SUBJECTED TO UNINEPHRECTOMY AND FOOD RESTRICTION. Rosen, Victor J.; Cole, Leonard J.; Wachtel, Louis W.; Doggett, Reuben S. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 19, 1967. 30p. (USNRDL-TR-67-119). CFSTI.

Weanling female Sprague-Dawley rats were utilized to study the effect of undernutrition on the ultrastructure of accelerated irradiation induced glomerulosclerosis. Following uninephrectomy and 2000 rad x-rays to the remaining kidney, a severe, destructive glomerulosclerosis appeared within 7-8 weeks. Food restriction to the point of significant growth retardation resulted in a marked inhibition of the genesis of the glomerular lesion. Ultrastructurally there was marked reduction in all cytoplasm organelles and a striking reduction in mesangial matrix deposition. These observations show that food restriction retards the development of manifestation of what is considered to be a direct radiation effect on the kidney; and add further confirmation to the thesis that a stimulus for growth, combined with the direct effects of radiation accelerates the development of glomerulosclerosis, while growth retardation has a profound inhibiting effect on the evolution of the lesion. (TAB)

36342 DEUTERIUM OXIDE EFFECT ON SPERMATOGENESIS IN THE MOUSE. Oakberg, E. F.; Hughes, Ann M. (Oak Ridge National Lab., Tenn. Univ. of California, Berkeley). Exp. Cell Res., 50: 306-14(May 1968).

Drinking water containing 30 percent D_2O by volume was given to young adult S and C57 black mice. Quantitative histological study of the testes at weekly intervals indicated a progressive decline in number of spermatogonia to about 60 percent of control by the end of the 7-week experimental period. Number of degenerating mononuclear giant cells, abnormal clumps of spermatids, and frequency of tubules with missing cell layers were more frequent in D_2O-treated mice. The normality of spermatogenesis was surprising in view of the known effect of D_2O on fertility of C57 male mice, and investigations on both number and functional capacity of spermatozoa of these males are indicated. (auth)

36343 EXPERIMENTAL ULTRAVIOLET LIGHT CARCINOGENESIS: A STUDY OF CROTON OIL PROMOTING EFFECTS. Epstein, John H.; Roth, Harry L. (Univ. of California, San Francisco). J. Invest. Dermatol., 50: 387-9(May 1968).

The effect of chemical stimulation of uv induced carcinogenesis was examined in mice utilizing croton oil promotion techniques. A single exposure to 1.3×10^7 ergs/cm^2 of mid ultraviolet light energy followed by biweekly applications of croton oil resulted in 9 tumors within 18 months. Only one apparently spontaneous tumor appeared in the control groups. All but one of the tumors produced were larger than 50 cu mm and only one growth per tumor bearing animal was noted. Multiple papilloma formation and significant tumor regression were not seen. These results suggest that croton oil stimulated tumor formation, the characteristics of which were established by the single ultraviolet light exposure. The mechanism of this stimulation remains to be determined. (auth)

36344 HEMATOPOIETIC STIMULATION AND RADIOSENSITIVITY IN MICE. Sugahara, Tsutomu; Tanaka, Tomizo; Vacek, Antonin (Kyoto Univ.). J. Radiat. Res., 8: 152-60(Sept.-Dec. 1967).

Differences in 30-day percent survival in dd/YF male mice after a single dose of 600 R were observed after three kinds of hematopoietic stimulation, i.e., fasting and refeeding, heavy breeding and low barometric treatment. Erythropoietic activity was estimated by measuring ^{59}Fe uptake for six hours into the femur and spleen after the stimulation. The number of colony forming cells in the bone marrow was determined by adopting the transplantation method. Mice appeared to be resistant when the hematopoietic activity is high and hematopoietic stem cells in the marrow are reduced. (auth)

36345 EFFECTS OF ANAESTHESIA ON SACCHARIN AVERSION OF RATS TO RADIATION EXPOSURE. Okajima, Shunzo; Atsuta, Joe (Nagasaki Univ. School of Medicine). J. Radiat. Res., 8: 147-51(Sept.-Dec. 1967).

No significant effect of anaesthesia during irradiation on saccharin avoidance behavior was found in the 100 R x-irradiated rats whether the initial presentation of saccharin as a conditioning stimulus was given before or after the irradiation. The results obtained seem to indicate that saccharin avoidance behavior did not result from the discrimination of irradiated rats while receiving radiation. (auth)

36346 THE EFFECTS OF X-IRRADIATION ON THE RAT BEHAVIOR. Okajima, Shunzo; Atsuta, Joe (Nagasaki Univ. School of Medicine). J. Radiat. Res., 8: 141-6(Sept.-Dec. 1967).

Conditioned aversion to saccharin solution was demonstrated by whole-body irradiation in doses of more than 25 R in 100-day-old Wistar rats. The degree of aversion depended on radiation dose and the duration of this effect depended on the age of the irradiated rats. The repeated conditioning produced the same degree of aversion as in the first conditioning. The sugar solution had no effect as a conditioning stimulus. (auth)

36347 EFFECT OF ULTRAVIOLET IRRADIATION ON EGG HATCH, SUBSEQUENT LARVAL DEVELOPMENT, AND ADULT LONGEVITY OF THE TOBACCO BUDWORM AND THE BOLLWORM. Guerra, A. A.; Ouye, M. T.; Bullock, H. R. (Entomology Research Div., Brownsville, Tex.). J. Econ. Entomol., 61: 541-2(Apr. 1968).

Eggs (18-24 hours old) of the tobacco budworm, Heliothis virescens (F.), and the bollworm, H. zea (Boddie), were exposed to ultraviolet irradiation of a short (2537 A) or a long (3600 A) wavelength to determine the effect of these rays on egg hatch, subsequent development, and adult longevity. A gradual increase in time of exposure to the short-wave rays caused a gradual decrease in the percentage egg hatch, and no hatch occurred after an exposure of 20 minutes. However, the hatch was not greatly affected until exposures were longer than 1 minute. Eggs exposed to the long-wave rays had a comparable percentage hatch in all treatments. The treatments had no influence on time for larval and pupal development or on the longevity of adults emerging from embryos that survived the treatment. (auth)

36348 REPAIR OF THE HEMOPOIETIC CELLS AFTER A WHOLE-BODY X-IRRADIATION OF MICE. Paribok, V. P.; Pereverzev, A. E. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1503-9(Dec. 1967). (In Russian).

X radiation of mice by the dose fractionation method, under normal and hypothermic (16° to 20°C) conditions, showed that the increase in survival of hemopoietic cells was caused by repair. The repair phenomenon can be observed even under unfavorable conditions, i.e., during the radiosensitive stage of the mitotic cycle. (H.L.W.)

36349 SUMMARY: EVIDENCE FOR VIRUSES IN HUMAN LEUKEMIA AND BURKITT'S TUMOR. Bryan, W. Ray (National Cancer Inst., Bethesda, Md.). Cancer Res., 27: 2507-9 (Dec. 1967).

Evidence for the presence of viruses in human leukemia and lymphoma (Burkitt's tumor) is reviewed. Results are reported from a study on the effects of x radiation on the growth of virus-carrying human lymphoma cells in culture with leukocytes from normal infants. The irradiated lymphoma cells failed to grow but the infant leukocytes grew progressively and produced virus. (C.H.)

36350 HEREDITARILY FIXED CHANGES OF ULTRA-VIOLET FLUORESCENCE INTENSITY IN IRRADIATED LYMPHOSARCOMA CELLS. Kondrat'eva, T. M.; Pinto, R. I. (Central Research Inst. of Roentgenology and Radiology, Moscow. Inst. of Cytology, Leningrad). Tsitologiya, 9: 1517-26(Dec. 1967). (In Russian).

Changes in the intensity of uv fluorescence of transplantable rat lymphosarcoma cells after irradiation in vivo with 500 R and of their descendants in non-irradiated animals (upon subsequent transplantations) were studied. It was established that: the average uv intensity of irradiated cells increases within the first 24 hours after irradiation and then remains at the same level up to the death of irradiated animals (for 2 to 3 days); in descendants of irradiated cells the increased fluorescence intensity persists in some generations (during the whole process of investigation); when non-irradiated lymphosarcoma cells are introduced to animals preirradiated with 500 R no increase of uv fluorescence intensity is observed in descendants of those cells. It is concluded that the increase in the fluorescence intensity of lymphosarcoma cells induced by irradiation is a hereditarily fixed radiation effect. (auth)

36351 RADIORESISTANCE OF AMOEBA PROTEUS IN RELATION TO IRRADIATION CONDITIONS AND MITOTIC STAGES. Kal'nii, V. S. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1535-42(Dec. 1967). (In Russian).

The effect of the dosage intensity and the radiosensitivity of different mitotic stages of synchronized cultures was determined. Amoebae appeared to be most sensitive to irradiation during the first three hours after division, while 3.5 hours after division their radiosensitivity sharply decreased. On increasing the intensity of dosage from 4.3 to 30 kr/min, the isoeffective dose decreased twice, while the number of amoebae that died after the second division also decreased. The above data are in good agreement

with the hypothesis on rapidly proceeding processes of postradiation recovery in amoebae. (auth)

36352 PERMEABILITY OF THE CORNEA EPITHELIUM TO MUTAGENIC UV IRRADIATION. Paribok, V. P.; Genter, E. I. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1564-7(Dec. 1967). (In Russian).

The uv permeability of the mouse cornea epithelium was recorded by spectrophotometry and uv microphotometry. At λ = 2537 Å, the nuclei of mitotically active basal cells of the epithelium received more than 6 percent of the total irradiation obtained by the cornea. The significance of the results presented is discussed for the purposes of estimation of a possible mutagenic effect of uv irradiation on the cornea. (auth)

36353 RELATIONSHIP BETWEEN THE TIME OF DEATH OF BLOOD CELLS AND THE IRRADIATION DOSE. Pinto, R. I. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1568-70(Dec. 1967). (In Russian).

The experimental evidence obtained by the luminescence method in relation to the time of death of in vitro irradiated lymphocytes and polymorphonuclear neutrophils of rat peripheral blood (in doses ranging from 1250 to 10,000 R) is statistically treated for the evaluation of the effective time of death T_{50} (time of death of 50 percent of irradiated cells). On the basis of calculations, graphs were drawn in logarithmic coordinates to show a relation of T_{50} to the irradiation dose. The graphs proved to be approximately linear which suggests the presence of some degree dependence of either kind: $T_{50} = C/D^n$ or $T_{50} = C/(D-D_0)^n$ with the threshold dose of irradiation (the smallest dose inducing the death of irradiated cells). In the present experiments, the value of "n" is the same for both lymphocytes and polymorphonuclear neutrophils. (auth)

36354 CHANGES IN DUODENAL CONTENTS, BILIARY AND PANCREATIC SECRETIONS FOLLOWING A SINGLE THERAPEUTIC X-RAY DOSE. Dalla Palma, L.; Cappellini, M.; Taddei, L.; Becciolini, A. (Univ., Florence). Nunt. Radiol., 32: 855-81 (Sept. 1966). (In Italian).

Changes in the duodenal contents and in the biliary and pancreatic secretions were observed following a single therapeutic x-ray dose to the epigastric region. Corresponding observations were made on non-irradiated patients. Following doses sufficient to cause acute radiation sickness, a decrease in duodenal fluid, an increase in biliary secretion, and increase in trypsin concentration were noted. (H.L.W.)

36355 THE EFFECT OF RADIATION ON THE GROWTH OF VERTEBRAE IN THE TAILS OF RATS. I. SINGLE DOSES OF X-RAYS AND THE EFFECT OF OXYGEN. Dixon, B. (Hammersmith Hospital, London). Int. J. Radiat. Biol., 13: 355-68(1967).

Vertebrae in the distal half of the tails of week-old rats were x irradiated either with the blood supply occluded or while the animals were breathing 10%, 15%, 21%, 100% oxygen at normal, and 100% oxygen at increased, atmospheric pressures. Their radiosensitivity, as determined by stunting in growth of the diaphyses, was 1.0, 1.15 to 1.50, 1.8, 2.3, 2.5, and 2.8, respectively, under the conditions used. If stunting can be ascribed quantitatively to the loss of reproductive integrity of epiphyseal stem cells, then it may be deduced that the stem-cell population was uniformly hypoxic under normal conditions. Only at 10% oxygen was the stem-cell sensitivity heterogeneous. The response under this condition indicated a mixed population of hypoxic and anoxic cells. Estimates of cellular oxygen tension under each of the intermediate conditions of oxygenation were made. (auth)

36356 PROLIFERATION KINETICS OF X-IRRADIATED MOUSE L CELLS STUDIED WITH TIME-LAPSE PHOTOGRAPHY. I. EXPERIMENTAL METHODS AND DATA ANALYSIS. Thompson, Lawrence H.; Suit, Herman D. (Univ. of Texas, Houston). Int. J. Radiat. Biol., 13: 391-7(1967).

The technique of time-lapse photography provides a direct means of studying the proliferation kinetics of cells in vitro. A specially constructed system for large-field photography of mammalian cells and the method of analyzing cell-proliferation data from the films are described. Results from one experiment with mouse L cells are given. The culture was photographed before and after a single large dose of x rays. The effects of radiation on generation time, probability of division, and other parameters, were found to be strongly dependent on the age of the cell at the time of irradiation. (C.H.)

36357 HYPOXIA AND RECOVERY IN GROWTH CARTILAGE IN VIVO. Kember, N. F. (Royal Free Hospital Medical School, London). Int. J. Radiat. Biol., 13: 387-90(1967).

Hypoxia within the growth cartilage of rat tibiae was induced by tying a tourniquet about the thigh of the animal. Hypoxic limbs were exposed to 2400 rads x radiation, following which the tourniquet was released and retied 6 hr later, when a second dose of 2400 rads x radiation was given. The mean survival level measured by the clone count method in the irradiated limbs was 4.1×10^{-4}. This compared with an average value of 5.7×10^{-4} for a 24-hr aerobic recovery period between hypoxic irradiations. When these values were compared with the survival level for a single dose of 4800 rads given under hypoxic conditions, a recovery ratio of about 20 was obtained. Preliminary results are also reported from studies using aerobic irradiations but hypoxic recovery periods. (C.H.)

36358 EFFECT OF THYMIC IRRADIATION ON THE DEVELOPMENT OF NEW-BORN MICE. Sundaram, K.; Bains, G. S.; Moorthy, P. S. (Bhabha Atomic Research Centre, Bombay). Int. J. Radiat. Biol., 13: 335-42(1967).

An x ray dose of 900 rads to new-born strain A mice with partial shielding of the inferior extremities, resulted in death from a fatal wasting disease before they were six weeks old. Shielding of the thymic area during irradiation prevented the development of the disease. In addition, the wasting disease was prevented in a high percentage of animals by transplantation of fresh thymus from new-born animals within 48 hours after irradiation. Transplantation carried out 2 weeks after irradiation was ineffective. Animals four to six days old at the time of irradiation did not develop the wasting disease. On the basis of these findings, the role of the thymus in lymphopoiesis and immunological capacity is discussed. (auth)

36359 RADIATION SENSITIVITY AND POST-IRRADIATION REPAIR OF MOUSE LYMPHATIC CELLS IN VIVO AND IN VITRO. A STUDY WITH THE PARENT TO F_1 HYBRID GRAFT-VERSUS-HOST REACTION. Vos, O. (TNO, Rijswijk, Netherlands). Int. J. Radiat. Biol., 13: 317-33(1967).

The killing-effect of lymphatic cells from one of the parental strains in F_1 hybrid mouse recipients was used as a graft-versus-host reaction in determining the percentage of lymphatic cells that maintained their reproductive integrity (survival percentage) after x irradiation. The same radiosensitivity of lymph-node cells (D_0 circa 85 R) was found when the cells were irradiated either in the donor (before the suspension was prepared), in vitro, or in the recipient within four hr after injection. If irradiated 24 hours after inoculation the cells were more resistant, but it was not certain whether this really meant an increase in the resistance of the cells or whether a proliferation of cells was involved. Cells derived from mice presensitized by C57BL skin transplants showed the same sensitivity as normal lymph-node cells. No difference was found in radiosensitivity of lymphatic cells from lymph nodes, spleen, or peripheral blood. The oxygen-enhancement factor of lymph-node cells was about 2.7. It was concluded that lymphatic cells participating in the graft-versus-host reaction had a similar sensitivity for x rays as other mammalian cells. Differences in radiation sensitivity of the immune response in whole animals relative to the time of irradiation and antigen injection, and differences in radiosensitivity of the primary and secondary immune response were difficult to explain by variations in radiosensitivity of the stem cells giving rise to the immune reactions. (auth)

36360 RADIOSENSITIVITY AND BIOLOGICAL PROPERTIES OF TUMOURS. XIII. FREE AND BOUND RIBOSOME LEVELS AND PROTEIN SYNTHESIS OF TWO TUMOUR TYPES, CONTROL AND X-IRRADIATED. Mukerjee, Himansu; Goldfeder, Anna (New York Univ.). Int. J. Radiat. Biol., 13: 305-16(1967).

Two types of isologous mouse mammary tumors of different growth-rates (H, slow growing and G, rapidly growing) were investigated in respect to ribosomal distribution patterns, endogenous protein synthesis by the use of ^{14}C-leucine incorporation, and the effect of x irradiation on these processes. Sedimentation patterns of ribosomes of both tumor types appeared similar, and their monomer peaks corresponded to 73 S particles. Approximately 70% of the total ribosomal population of each tumor type consists of monomers, dimers, and lower oligomers. Total ribosomal population of H appeared greater than that of the G tumor. The percentage of free ribosomes in G was higher than in the H tumor. Ribosomal protein and RNA levels as well as ^{14}C-leucine incorporation were higher in the H than in the G tumor, corresponding to the higher concentration of ribosomes in the former. Maximum uptake of ^{14}C-leucine was reached at 4 hours in the H and at 3 hours in the G tumor, 3000 R x radiation resulted in approximately 50% reduction of the total ribosomal population of both tumor types, greater release of free ribosomes in G than in the H tumor, and reduction of approximately 90% in protein synthesis in the H and 50% in the G tumor at 1 hour after irradiation. The majority of the ribosomes in free state predominated in the irradiated G tumor. (auth)

36361 A FAILURE OF SPECIFIC INHIBITORS TO AFFECT SURVIVAL OF CHINESE HAMSTER CELLS EXPOSED TO ULTRA-VIOLET LIGHT. Arlett, C. F. (Atomic Energy Research Establishment, Wantage, Eng.). Int. J. Radiat. Biol., 13: 369-76(1967).

No change in survival of two Chinese hamster cell lines was found when any of the following inhibitors were added in various concentrations to the culture medium after exposure to ultraviolet light: acriflavine, caffeine, theophylline, chloramphenicol, cycloheximide, actinomycin D, and hydroxyurea. Acridine orange, puromycin, and reduced temperature were tested with one of the cell-lines and were without effect. (auth)

36362 FORMAL DISCUSSION: EPIDEMIOLOGY OF ACUTE LEUKEMIA AND BURKITT'S TUMOR. Heath, Clark W. Jr. (National Communicable Disease Center, Atlanta). Cancer Res., 27: 2439-40(Dec. 1967).

The incidence of leukemia in patients with polycythemia vera following treatment with radiation, especially with multiple doses of ^{32}P, is discussed. It is pointed out that the incidence of leukemia in these patients exceeds the incidence expected to result from irradiation alone and suggests that persons with polycythemia are particularly susceptible to the leukemogenic effects of radiation. The possible effects on radiotherapy of chronic granulocytic leukemia on the time of onset of acute leukemia are also discussed. The incidence of Burkitt's tumor in children in central Africa, and the relation of this tumor to the incidence of leukemia in children in Africa, is discussed. (C.H.)

36363 BEHAVIOR OF VARIOUS LYMPHOCYTE FORMS AND LYMPHOID CELLS UNDER THE INFLUENCE OF IONIZING RADIATION. Jorke, D.; Wedekind, L. (Staedtische Krankenhaus, Jena, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed., 108: 104-15(Jan. 1968). (In German).

The behavior of various types of lymphocytes (large, small, follicle and sinus lymphocytes) and of other lymphoid cells was studied in patients undergoing therapeutic irradiation and in occupationally exposed individuals. Thirty-five normals were used as controls. Therapeutic irradiation with x-rays, betatron or radiocobalt produced a leucopenia and lymphopenia, but only an initial reduction and subsequent rise in the number of lymphoid cells. In occupationally exposed individuals (physicists, radiologists) the total numbers of leucocytes and lymphocytes were normal but there was an increase in lymphoid cells and of the large and sinus lymphocytes, but a reduction in small and follicle lymphocytes. These changes were regarded as the cellular expression of RES activation. The changes showed closer correlation with duration than dose. The hematological effects described were useful for early recognition of radiation exposure and for the hematological supervision of exposed persons. (auth)

36364 INFLUENCE OF RADIOSENSITIVITY OF THE BODY TO THE CHARACTER OF FUNCTIONAL CHANGES OF THE VESTIBULAR ANALYSER AFTER IONIZING RADIATION. Farber, Yu. V.; Tabakova, L. A. Byull. Eksp. Biol. Med., 65: No. 4, 51-3(Apr. 1968). (In Russian).

The threshold sensitivity of the vestibular analyzer in rabbits with a low index of nystagmus was elevated by exposure to radiation doses of 50 R. In rabbits with a high threshold for the development of nystagmus, the vestibular analyzer was more sensitive to stimulation. Those animals in which excitability of the vestibular analyzer was lowered were more radiosensitive. (auth)

36365 EXPERIMENTAL HYPOPITUITARISM IN SWINE: A STEREOTAXIC METHOD OF INDUCING THE CONDITION WITH BETA IRRADIATION. Roesel, O. F.; Neher, G. M. (Purdue Univ., Lafayette, Ind.). Amer. J. Vet. Res., 28: 1181-90 (July 1967).

Destruction of hypophyseal tissue in situ was induced in 26 sexually immature male swine with 50 mCi of ^{90}Sr sealed in the tip of a 19-gauge needle. A stereotaxic instrument was fixed to the dorsal surface of the skull and was used to pass a shield needle with sylet between the cerebral hemispheres, through the anterior genu of the corpus callosum, between the lobes of the cerebrum just rostrally to the septum, through the dorsal part of the rostral wall of the hypothalamus, the third ventricle, and finally in the caudal edge of the hypophyseal stalk, with the tip of the needle located caudally to the pars distalis. Position of the shield needle was verified radiographically; the stylet was removed and the needle with ^{90}Sr was inserted. Irradiation exposures lasted from 10 to 50 minutes. In the pigs 15 weeks after irradiation, the extent of destruction of anterior pituitary gland tissue was between 60 and 96%. Signs of hypopituitarism were evident when 80% or more of the pars distalis was destroyed. The procedure was relatively rapid and reliable, and seemingly caused no untoward effects in the central nervous system. (auth)

36366 RADIATION INJURIES TO PRIMITIVE SPERMATOBLASTS OF MICE. Schnetter, Martin; Langendorff, Hanns; Schwaier, Anita (Univ., Freiburg i. B. Naturkundemuseum, Freiburg i. B.). Strahlentherapie, 135: 337-45(Mar. 1968). (In German).

Forty-four mouse embryos were irradiated with x rays (150 R), at the age of three, five, six, and seven days. Histological studies were done at the ninth and the tenth day and compared with 70 controls. The primordial germ cells could then be easily recognized. General damage especially of the mesenchyme was higher when embryos were irradiated earlier, but the primordial germ cells were damaged by irradiation only on the seventh day. Their number was reduced to one-third or one-quarter and their distribution was different from the controls. It was concluded that the precursor cells had a critical period before their differentiation toward typical migrating cells, which happened when the first biochemical reactions of the differentiation occurred. (auth)

36367 EFFECTS OF ^{90}Y MICROSPHERES ON NEOPLASTIC METASTASES IN THE BLOOD. Agostino, D. (Cornell Univ., Ithaca, N. Y.). Nunt. Radiol., 32: 883-92(Sept. 1966). (In Italian).

The intravenous inoculation of ^{90}Y microspheres reduced the number of circulating cancer cells in the blood. The subacute inoculation of blood of animals treated with ^{90}Y microspheres reduced significantly the number of takes. Pulmonary metastases were present in 77% of the control animals and 9.8% of the ^{90}Y microspheres treated rats. (auth)

36368 EFFECT OF 19-NORTESTOSTERONE PHENYLPROPIONATE (SUPERANABOLON) ON ERYTHROPOIESIS IN NORMAL AND IRRADIATED RATS. Travnicek, T.; Neuwirt, J.; Janousek, V.; Broulik, P.; Taborsky, J.; Taborska, E. Sb. Lek., 68: 105-8(Apr. 1966). (In Czech).

The effect of an anabolic steroid on various parameters of erythrocyte formation was studied in adult Wistar rats. The 72 male rats were divided into 4 groups of 18 each. The first group served as a control. The rats of the second group were given every third day 2.5 mg of 19-nortestosterone phenylpropionate (Superanabolon) per 100 g body weight. The animals of the third and fourth group were exposed to a single whole-body dose of 600 R of x rays and the animals of group 4 were given Superanabolon as in group 2. On the third, seventh, and fourteenth day in each group 6 rats were killed and examined. The following parameters of erythropoiesis were examined: hematocrit, hemoglobin, circulating erythrocyte and reticulocyte counts, and uptake of injected ^{59}Fe in circulating erythrocytes and in bone marrow from 4 different sites. Although in some instances the steroid seemed to stimulate red cell formation, Superanabolon administered in this way did not have a marked influence on erythropoiesis of normal male rats or on the restoration of erythropoiesis in irradiated animals. (BBB)

36369 MULTIPLICATION OF SALMONELLA ENTERITIDIS IN X-IRRADIATED AND NORMAL MICE. Shechmeister, I. L. (Southern Illinois Univ., Carbondale). Lab. Anim. Care, 17: 585-8(Dec. 1967).

Irradiated mice are highly susceptible to infection with S. enteritidis; a lethal dose of this agent is about 1/3 normal (10^2 intraperitoneally inoculated Salmonella) for animals exposed to a sublethal dose (350 R) of total-body radiation. Mice seemed to die when the concentration of these organisms reached a certain level, apparently the same in irradiated and nonirradiated mice. Experiments were conducted to test this hypothesis and to establish a terminal concentration of S. enteritidis. Multiplication of intraperitoneally injected Salmonella was determined from blood and peritoneal washings. The number of bacteria in mice inoculated with 1.4×10^4 to 1.4×10^8 organisms increased markedly from the 11th hours to the 12th day after irradiation with 350 R, and was correlated with the mortality of inoculated irradiated animals. No positive samples of blood and peritoneal washings were obtained from the inoculated control mice after the first day. Bacterial concentration at death in inoculated-nonirradiated and in inoculated-irradiated mice was the same, and was independent of the radiation dose (350 to 550 R) and the concentration of bacterial inoculum (6×10^4 to 3.7×10^7 organisms). However, the time to death was significantly shorter in the irradiated than in the nonirradiated mice. (BBB)

36370 PATHOGENESIS OF X-IRRADIATION EFFECTS IN THE MONKEY CEREBRAL CORTEX. III. HISTOPATHOLOGIC FINDINGS. Roizin, Leon (New York State Psychiatric Inst., New York). Brain Res., 7: 28-58(Jan. 1968).

Microscopic studies were carried out to determine the localization, development, and overall character of the central nervous system histopathology of monkeys following x irradiation. Microscopic observations revealed structural alterations at 28 and at

44 weeks. [Cytoarchitectural disorganization and prominent neuronal loss were apparent in the irradiated cortex in contrast to the nonirradiated cortex. Focal and confluent areas of necrosis with surrounding astroglial reactions in gray and white matter were seen, and in the same areas progressive and regressive microglial and oligodendroglial alterations. Metamorphosis of microglial cells to rod forms was noted. Various degrees of vascular proliferation occurred, including telangiectatic changes, endarteritis, periarteritis, and occasional thromboses. Also seen were severe inflammatory reactions in areas undergoing necrosis, near blood vessels, and, more diffusely, with granulomata and exudates of mononuclear cells, glial nuclei, and histiocytes. The myelin changes varied markedly in character, with mild to moderate demyelination occurring as well as widespread demyelination with focal patchy loss, or even complete demyelination in white and gray matter involving whole gyri. Severe intracortical disorganization was also noted.] Histopathologic findings were summarized as follows: inflammatory exudate of predominantly lymphohistiocytic character, inflammatory reaction generally perivenous or periarterial with peri-, meso-, and/or endarteritis, at times leading to thrombosis, vascular walls and more frequently the perivascular spaces and tissues containing fibrinoid material, perivascular inflammatory exudate, predominantly circumscribed, also assuming diffuse and/or granulomatous features, areas of necrosis and malacia, at times, associated with the lesions, predilection of lesions in white matter more frequently in the later stages of the disease process which generally became progressive in character, and glial cells, microglia and astroglia, and to a lesser degree oligodendroglia, showing prominent progressive reactions followed by various metamorphic changes during the early development of the lesions. (BBB)

36371 PATHOGENESIS OF X-IRRADIATION EFFECTS IN THE MONKEY CEREBRAL CORTEX. IV. ALTERATION IN DENDRITIC ORGANIZATION. Schade, J. P. (Central Inst. for Brain Research, Amsterdam); Caveness, W. F. Brain Res., 7: 59-86(Jan. 1968).

The effect of x irradiation on the structural organization of the monkey cerebral cortex was examined as a function of time, to provide a morphological basis for the functional changes described in previous parts of this series. At 72 hr and one week postirradiation examination of the neuropile, with particular attention to the processes of the pyramidal cells in all layers, revealed no apparent difference between the irradiated (right) and homologous nonirradiated (left) cortex. At four weeks postirradiation the neuropile appeared less dense on the right (irradiated) side as compared with the left. Loss of dendritic branches was the result of a reduction in basilar processes with little interference with the apical stalk or its branches. [The basilar branches appeared shorter, thicker, with alteration and loss in pedunculated bulbs. The intersections and dendritic length in the irradiated side were reduced to about one half that in the control side. Distal dendritic branches were more severely reduced, while the proximal dendrites were less affected.] At 12 weeks postirradiation there was an apparent loss in nerve cells and a distinct reduction in dendritic ramifications in the irradiated cortex. [The shortened branches were irregularly thickened with alteration in spines. Many coarse and fine dendrites were devoid of such processes. The changes noted at 12 weeks were accentuated at 20 weeks, with greatest involvement in the basilar dendrites but some impairment being evident in the apical branches. Some apical stalks were angulated in a corkscrew manner.] At 28 weeks the quantitative reduction in number of intersections and branching points was about 70%. The packing density of the neurons was decreased to about ⅓ the value in the nonirradiated cortices. It was concluded that the reduction in the size and closer aggregation of perikarya resulted from reduction in the length and amount of branching of the dendrites and from a reduction in the density of the axon network. The changes in the dendritic organization after irradiation were the reverse of those found in pre- and postnatal development of the cerebral cortex. The pattern of chemical architecture of the neuron might be disturbed, causing an imbalance of the anabolic and catabolic mechanisms. (BBB)

36372 INFLUENCE OF CORTISONE ON THE DEVELOPMENT OF LESIONS CAUSED BY A LOCAL IRRADIATION OF THE GASTRIC MUCOSA. Melon, J.; Haot, J.; Betz, E. H. (Univ., Liege). Pathol. Eur., 2: 322-36(1967). (In French).

To study the effect of x radiation on the gastric mucosa, the stomach of rabbits was surgically exteriorized and a contact-therapy x-ray device operated at 50 KV was used to deliver doses of 2500, 3000, 4000, or 5000 R directly to the mucosa. Some animals treated with 2500 R also received cortisone, beginning 15 days postirradiation, at a dose of 5 mg/Kg/day. The resulting gastric lesions were examined histologically up to 120 days later. Ulcers appeared rapidly after 4000-R local irradiation and extended into the gastric wall. Their extension was dependent on the x-ray dose. The dose of 2500 R, after a delay of 12 days, caused more superficial erosion of the mucosa; some of these erosive lesions were replaced later (after the 40th day) by true peptic ulcers. After the 70th day, a progressive sclerosis developed in the tissues surrounding the ulcers; healing, however, was very slow and the ulcers were still present after the 120th day. In the study of the effects of cortisone on these experimental gastric lesions, daily injections given after the 15th day did not increase the incidence of ulcers but seemed to accelerate their formation since they could be detected as soon as three days after the beginning of the treatment. Sclerosis around the lesions was inhibited by cortisone treatment. (BBB)

36373 INFLUENCE OF TEMPERATURE ON X-RAY SENSITIVITY OF MOUSE BONE MARROW CELLS IN VITRO. Smith, L. H.; McKinley, T. W. Jr. (Oak Ridge National Lab., Tenn.). Radiat. Res., 32: 441-51(1967).

Radiation response of mouse bone marrow cells in terms of their erythropoietic activity was determined as a function of the following in vitro environmental conditions: temperature during and after (up to 6 hours) x irradiation and temperature during the incubation period between two x ray exposures. Results indicated that radiosensitivity was not a function of the temperature (2°C, 25°C, 37°C) during irradiation; in the range 2° to 30°C, incubation temperature during the six-hour period after irradiation (100 R) had no detectable influence on radiation response of cells; in the 30° to 40°C range, injury to irradiated cells was directly related to incubation temperature; and the degree to which cell survival was enhanced by fractionation of the exposure was directly related to the temperature at which cells were incubated between the two exposures. (auth)

36374 LATE EFFECTS OF FAST NEUTRONS AND GAMMA RAYS IN MICE AS INFLUENCED BY THE DOSE RATE OF IRRADIATION: LIFE SHORTENING. Upton, A. C.; Randolph, M. L.; Conklin, J. W. (Oak Ridge National Lab., Tenn.). Radiat. Res., 32: 493-509(1967).

The influence of dose and dose rate on the life-shortening effectiveness of 1-MeV neutrons, 5-MeV neutrons, 250 kVp x rays, and ^{60}Co γ rays was investigated in RF mice. Male and female mice were exposed to graded doses of whole-body irradiation at dose rates of 10^{-4} to 10^{2} rads/min, beginning at 10 weeks of age. Exposures requiring more than one day were continued for 23 hours daily until 50% of the mice had died—that is, unless a predetermined dose was accumulated sooner. The RBE of the neutrons increased with decreasing dose rate from about three at the highest dose rates to more than 10 at the lowest dose rates, owing to a decreased effectiveness of the γ rays at low dose rates. (auth)

36375 LATE EFFECT OF FAST NEUTRONS AND GAMMA RAYS IN MICE AS INFLUENCED BY THE DOSE RATE OF IRRADIATION: METHODOLOGY OF IRRADIATION AND DOSIMETRY. Randolph, M. L.; Slater, Marvin; Upton, A. C.; Conklin, J. W. (Oak Ridge National Lab., Tenn.). Radiat. Res., 32: 475-92(1967).

A large-scale series (99 groups totaling more than 11,000 mice) of experiments was performed on the late effects in mice of photon and neutron irradiation as influenced by the dose rate. Continuous irradiations were performed with Po–Be fast neutrons and ^{60}Co γ rays. This paper, the first of a series, describes aspects of the methodology common to all the studies, with emphasis on the radiation dosimetry. Comparative results obtained with various dosimetric systems are presented, as well as estimates of the variation of scattered radiation versus distance. A method for estimating neutron relative biological effectiveness was developed that corrects for the effect of the γ-ray contamination in mixed neutron and γ radiation fields. (auth)

36376 LENS FINDINGS IN ATOMIC BOMB SURVIVORS: A REVIEW OF MAJOR OPHTHALMIC SURVEYS AT THE ATOMIC BOMB CASUALTY COMMISSION (1949-1962). Miller, Robert J. (Sunnyvale Medical Clinic, Calif.); Fujino, Tadashi; Nefzger, M. Dean. Arch. Ophthalmol. (Chicago), 78: 697-704(Dec. 1967).

Lens injuries in atomic bombing survivors fell into three categories. Severe effects of radiation included marked lens changes that were recognized early if the patient did not succumb to the effects of radiation. A large posterior subcapsular plaque, doughnut opacity, or bivalve opacity, with resultant diminution of central visual acuity, was usually seen. Minimal radiation effects consisted of a polychromatic sheen that seemed to be in the plane of the posterior capsule of the lens and could be seen only with the slit-lamp biomicroscope. Of all the patients examined in Hiroshima and Nagasaki only 20 were in the first category. Moderate changes of the second type occurred relatively infrequently in

the total survivors within 2000 m of the hypocenter, but their rate increased to about 15% among the few survivors within 500 m. A few (five to six) were described as having slight or very slight changes. At present, most patients with positive findings appeared to be in the third category. Rates could exceed 60% among survivors within 800 m and, in association with nearly total epilation, could exceed 80%. There was no evidence of an appreciable diminution in visual acuity among exposed survivors, or in association with changes of the posterior subcapsular region of the lens. (BBB)

36377 PHENOMENOLOGY OF RADIATION EFFECTS ON ORGANS AND ORGAN SYSTEMS. I. HISTOPATHOLOGY OF THE ACTION OF IONIZING RADIATION ON HIGHER ORGANISMS (ANIMALS AND MAN). Cottier, Hans (Univ., Bern). pp 35-272 of Handbuch der Medizinischen Radiologie. Vol. II. Pt. 2. Berlin, Springer Verlag, 1966. (In German).

General radiohistopathology is discussed in terms of radiosensitivity and radiation resistance of tissues, characteristics of cytological and histological irradiation injuries, effects of radiation quality, energy, and dose fractionation on morphological cellular and tissue changes, and the significance of the type and state of the biological system for the morphologically detectable effects of irradiation in vitro and in vivo. Morphological evidence of irradiation effects on single cell systems, comparative radiosensitivity of various phases of cell reproduction cycles, radiosensitivity of various types of cells, irradiation effects on cells in organized tissues and in entire organisms, effects of physical, metabolic, and hormonal factors on morphological irradiation effects, significance of age, differences related to species, variety, and constitution, and effects of protective measures on irradiation effects are discussed. Reversible and irreversible irradiation effects, relations between ionizing radiations and neoplastic processes are itemized. Radiohistopathology of hematopoietic and lymphatic organs, and the reticuloendothelial system, connective tissue and musculature, cardiovascular system, skin and epidermal appendages, gastrointestinal tract, respiratory system, kidney and genitourinary system, male and female gonads, endocrine organs, and the nervous system is described. (BBB)

36378 PATHOGENESIS OF X-IRRADIATION EFFECTS IN THE MONKEY CEREBRAL CORTEX. I. INTRODUCTION. Caveness, W. F. (Columbia Univ., New York). Brain Res., 7: 1-4 (Jan. 1968).

Detailed studies were made of the x-irradiated cerebral cortex of Macaca mulatta to examine the nature of the changes leading to the brain injury occasionally seen in humans after the head has been subjected to radiotherapy. X irradiation, with a single exposure of 3500 R was chosen because this caused significant delayed effects in the spinal cord of the monkey, and because this dose was within the therapeutic range employed in humans. Post-irradiation observations indicated an intermittent functional course, as expressed by the electroencephalogram (EEG), that began as early as 24 hr. The first changes consisted of amplitude asymmetries, without alteration in rate, with less voltage over the irradiated than over the contralateral unexposed homologous cortex, more apparent during sleep than the waking state. Clinical signs were delayed for 20 weeks. Focal seizures preceded their advent, and did not persist with the progression of hemiparesis. With the onset of clinical signs, the EEG exhibited transient, paroxysmal seizure activity, and a slowing in rate with an increase in amplitude that was soon reflected from the opposite hemisphere. Sacrifice at 72 hr to 44 weeks, indicated anatomical changes at ultrastructural levels as early as 72 hr. Within the first 16 weeks there were collections of round cells, circumscribed or perivascular. Astrocytic proliferation or changes in microglia were seen as early as the first week and prominently by the fourth week. Chromatolytic and pyknotic changes in pyramidal cells were observed. Reduction in dendritic aborization was seen between the second and fourth week with a pronounced difference between the irradiated and nonirradiated sides thereafter. From the 18th week, necrosis in grey and white matter, accompanied by pronounced inflammatory, glial, and vascular reactions was noted. (BBB)

36379 PATHOGENESIS OF X-IRRADIATION EFFECTS IN THE MONKEY CEREBRAL CORTEX. VII. SUMMARY. Caveness, W. F. (Columbia Univ., New York). Brain Res., 7: 116-17 (Jan. 1968).

Changes occurring in the cerebral cortex of 24 young adult monkeys, selectively exposed to 3500 rad in a single local dose of x irradiation, were reported. In the right visual cortex, functional changes were monitored by evoked EEG responses from photic stimulation of the retina, and sequential anatomical examinations were carried out. The evoked responses of the visual cortex to photic stimulation showed a decrease in voltage over the irradiated side, an effect beginning soon after exposure. It became appreciable between six to 12 weeks, receded between 18 and 22 weeks, and was most pronounced between 28 and 44 weeks. A second functional change, beginning after 18 to 22 weeks, consisted of high-amplitude slow waves in the EEG that in some animals replaced the evoked response. Routine histological examination revealed significant histological changes in the irradiated cortex around the 20th week, with the beginning of destructive processes. At 28 and 44 weeks severe disorganization of cyto- and myeloarchitecture was accompanied by proliferative and degenerative changes in glial and vascular elements. At four weeks, well in advance of so-called radiation necrosis, Golgi–Cox preparations showed a significant reduction in the dendritic plexus of pyramidal cells, with a greater reduction in basilar than apical branches, and accompanied by alteration in the pedunculated bulbs. Beyond 20 weeks there was an obvious loss in cells, with distortion in the remaining neuropile. The first reduction in voltage of the evoked response from irradiated cortex was evidently related to the reduction in the dendritic plexus with its concomitant loss in synaptic surface. The second, more pronounced decrease in the evoked response, beyond 20 weeks, was related to an estimated dendritic loss of 60% and a cell loss of 30%. High amplitude slow activity reflected the underlying tissue destruction. Ultrastructural changes within the first week suggested early alteration in glycogen metabolism and protein breakdown. (BBB)

36380 PATHOGENESIS OF X-IRRADIATION EFFECTS IN THE MONKEY CEREBRAL CORTEX. II. IRRADIATION AND FUNCTIONAL CHANGES. Carsten, Arland L. (Brookhaven National Lab., Upton, N. Y.). Brain Res., 7: 5-27 (Jan. 1968).

The monkey (Macaca mulatta) cerebral cortex was subjected to localized x irradiation (3500 rad at 250-kV), particularly the visual cortex of the right occipital lobe, to permit quantitative measurements of evoked responses. Baseline EEG recordings for each animal were obtained for three months prior to irradiation. Following irradiation, the same degree of variability was evident as in the preirradiation records, so that the records for each animal as well as the mean response values for all of the experimental animals were examined. Deviation values were determined by analysis using a standard program in an IBM 7090 computer. A depression in mean evoked response appeared on the irradiated side as early as 24 hr. This relative depression increased until the sixth week, then slowly diminished until the 18th week, when both sides showed an equal response at an amplitude lower than that in the initial recordings. However, by 26 weeks a second wave of right-side depression was evident, which continued until the termination of the study at 44 weeks. Beyond the 20th week a different order of EEG activity began to appear, consisting of delta and theta waves, an expected reaction to injury. This was noted between 23 and 44 weeks. When this activity was prominent, the evoked response was modified or obliterated. Without stimulation, the extent of the delta activity and its reflection in the nonirradiated cortex were similar to the late reaction reported following irradiation of the sensorimotor cortex. (BBB)

36381 CARCINOMA OF THE BREAST. STAGE II: RADIATION RANGE. CAN SURVIVAL BE INCREASED BY POSTOPERATIVE IRRADIATION FOLLOWING RADICAL MASTECTOMY. Watson, Thomas A. (Univ. of Western Ontario, London). J. Amer. Med. Ass., 200: 136-7 (Apr. 10, 1967).

Incidence of radioinduced complications was referred to in a report on high-dosage postoperative irradiation for breast cancer. Supervoltage equipment provides a considerable advantage over conventional x ray, because higher tissue doses can be delivered with much less chance of complications than with conventional x ray. Thus, skin reactions seldom proceed beyond the stage of erythema even when high tissue doses, ~4000 rad in 3 weeks, are delivered. Fibrosis of the lung may be a late occurring phenomenon, but this is small in extent and is asymptomatic. Radiation sickness does not occur except in those who have been conditioned to expect it prior to treatment. Bone necrosis of the ribs or clavicle or brachial neuritis, consequent upon irradiation fibrosis, should not occur. When a combination of radical mastectomy and postoperative radiation therapy was employed, it was found that the incidence of severe complications, such as gross edema of the arm or major impairment of function of the upper limb, was only ~2%. (BBB)

36382 EEG FINDINGS IN WORKERS EXPOSED TO ELECTROMAGNETIC RADIATION AT CENTIMETER WAVELENGTHS. Ulc, M.; Svacina, J. Cesk. Neurol., 29: 402-6 (Nov. 1966). (In Czech).

The results of periodical examinations performed since 1943 at the Clinic of Occupational Pathology in Prague on 992 persons exposed to ionizing radiation are analyzed. Seventy-eight persons

(mostly physicians) had x-ray dermatitis of the hands, while leucopenia was found in 47 cases and radiation cataract in five cases. The mean leucocyte, neutrophil and lymphocyte counts were reduced, especially in doctors; in cases of industrial exposure, no statistically significant difference as compared to controls was noted. Thus the mean haematological values may be used to assess the effect of exposure on health. The changes were unrelated to length of exposure. (Occup. Safety and Health Abstr.)

36383 EFFECTS OF RADIATION ON THE HUMAN HEART: AN ELECTRON MICROSCOPIC STUDY. Burch, George E.; Sohal, Rajindar S.; Sun, Shih-chien; Miller, Gordon C.; Colcolough, Harry L. (Tulane Univ., New Orleans). Arch. Intern. Med., 121: 230-4(Mar. 1968).

An ultrastructural study was made of the heart of a patient who died of myocardial disease with congestive heart failure following x radiotherapy for carcinoma of the thyroid. A total thyroidectomy was performed and postoperative irradiation was given with a total dose of 4800 rad to the thyroid bed and an additional dose of 5200 rad to the mediastinum through the chest wall via six ports. The fifth year after operation, the patient progressively developed nocturnal dyspnea and lethargy associated with diffuse cardiac enlargement and pulmonary congestion. Following death from heart failure, electron microscopic changes of radiation effects on the heart included disorganization of the nucleus, myofilaments, mitochondria, and sarcolemma. Intracellular edema in the perineurial region of the myofibers was noted. It was pointed out that myocardial lesions resulting from irradiation seemed to differ significantly from those of ischemia and infarction. However, it was not possible to define a specific subcellular lesion which was characteristic of irradiation. It seemed likely that the changes seen in the various membrane systems may have been casually related to the irradiation itself or some, as yet, poorly understood long-term result of its initial effects. Whether the changes seen were due primarily to myofiber damage or to irradiation vasculitis was likewise unknown. (BBB)

36384 PEMPHIGOID, BRONCHIAL NEOPLASM, AND RADIOTHERAPY. Abadir, R. (Univ. College Hospital, London). Proc. Roy. Soc. Med., 60: 1271-2(Dec. 1967).

Possible induction of pemphigoid, or bullous disease, by radiotherapy for lung cancer in a 53-yr-old man was reported. Two weeks after chest irradiation was begun, he developed an itchy rash. It consisted of erythematous, slightly raised, rounded patches on the trunk and limbs with vesicles or bullae at their borders. He had a few gigantic bullae, but no lesions in the mouth. Histology of a skin lesion showed a subepidermal blister containing eosinophil polymorphs that were also present around the dermal blood vessels. Whether the bullous disease was related to the neoplasm or whether radiotherapy precipitated it was discussed. Another case was cited as one of bullous erythema multiforme after irradiation of the spine for secondary carcinoma. Reexamination of the histology in this case revealed that the blisters were subepidermal and filled with eosinophils which made the two cases seem closely related. (BBB)

36385 LARYNGEAL CARCINOMA: SURGICAL TREATMENT AND RADIOTHERAPY. Semczuk, B.; Klonowski, S.; Peszynski, J. (Medical Academy, Lublin). Pol. Med. J., 5: 1436-41(1966).

Radiosensitivity of laryngeal cancer and incidence of complications with two types of x-ray therapy were reported in the course of analysis of 115 patients who underwent radical treatment (operative and x-ray therapy) because of laryngeal carcinoma in the period 1950 to 1960 and who were followed up for five yr. Surgical treatment was used for all carcinomas situated below the glottis, advanced carcinomas of the glottis limiting the mobility of the vocal cords, and neoplasms destroying the cartilaginous structure of the larynx. All adenocarcinomas and squamous cell carcinomas with a histological structure suggesting radioinsensitivity were treated surgically. Early forms of the carcinoma situated on the vocal cords with preserved mobility of the cords, and early or moderately advanced carcinomas situated in the epiglottic compartment were treated surgically or irradiated with x rays if they were radiosensitive. X-ray therapy was used particularly for carcinomas of the epiglottis that had marked radiosensitivity. Grade IV carcinomas were not considered suitable for irradiation. Insufficient radiosensitivity of the tumor and an infiltrating growth with destruction of the cartilaginous structure of the larynx were considered contraindications to radical irradiation. The overall percentage of five yr survivals in the surgical and irradiated patients was 44.7. It was observed that the application of x rays with an HVL of 3.0 mm Cu decreased the incidence of early local radiation complications three fold in relation to patients with similar clinical manifestations irradiated with x rays having an HVL of 1.5 mm Cu which enabled an increase of the total tumor dose an average of 8%. (BBB)

36386 INDUCED DOMINANT LETHALITY IN MICE BY ^{32}P. Reddi, O. S.; Vasudevan, B. (Osmania Univ., Hyderabad, India). Nature (London), 218: 283-4(Apr. 20, 1968).

Male mice were given an intraperitoneal injection of orthophosphate-^{32}P in doses of 50, 75, and 135 μCi, and 24 hours later were mated with untreated females. The mated females were dissected on the 15th day of gestation and the numbers of live and dead embryos and corpora lutea were recorded. It was found that the ^{32}P had a demonstrable effect on intrauterine deaths and the observations were clearly indicative of mutagenic effects. The results point to possible genetic hazards in indiscriminate use of radiophosphorus in human therapy. (UK)

36387 IONIZING RADIATION EFFECTS ON THE BONE SYSTEM OF THE FETUS AND PROTEIN FRACTIONS OF BLOOD OF PRELIMINARY THYROIDECTOMIZED AND IRRADIATED RATS. Adamyan, T. V. (Dept. of Radiobiology, Erevan). Biol. Zh. Arm., 20: No. 7, 20-3(July 1967). (In Russian).

The influence of chronic exposure to ionizing radiation on bone development in fetuses and proteic fractions in the blood serum was studied in thyroidectomized pregnant female albino rats irradiated with x ray or ^{60}Co γ rays daily at a dose of 1 R/day (total dose of 60 R). The general protein content of the blood serum of these animals remained normal; changes were observed in the albumin–globulin coefficient, the content of α-globulins (increase of 27%) and the content of β-globulins (decrease of 12%). The amount of γ-globulin was reduced considerably (42%). The preliminary thyroidectomy did not affect the bone structure of the fetus; chronic exposure to the γ or x radiation resulted in deformations of the bones of newborn rats. (R.V.J.)

36388 THE COURSE OF RADIATION SICKNESS INDUCED BY COMBINED EFFECTS OF IONIZING RADIATION AND LYASE ENZYMES IN ANIMAL ORGANISMS. Gambaryan, L. S.; Alaverdyan, M. I.; Ter-Avetisyan, A. T.; Garibyan, L. A.; Mnatsakanyan, N. A. (Lab. of Neurobionics, Erevan). Biol. Zh. Arm., 20: No. 7, 3-8(July 1967). (In Russian).

Studies of effects of radiation on the development of bacteremia in 260 albino mice x-irradiated at 200, 400, and 650 R and treated intraperitoneally with hyaluronate lyase 24 hr before irradiation showed that treatment with the lyase preparation considerably enhanced the induction of bacteremia. (R.V.J.)

36389 RADIATION EFFECTS ON STEADY-STATE CELL POPULATIONS. Lajtha, L. G. (Christie Hospital and Holt Radium Inst., Eng.). Radiat. Res., 33: 659-69(1968).

Many of the dividing normal tissues in the mammalian organism retain a great capacity of recovery after depopulation by, for example, ionizing radiations. The pattern of recovery, however, differs greatly from tissue to tissue, and the analysis of these recovery patterns may give useful information on the cellular kinetics of the tissues concerned, information that may be exploited in radiotherapy. Very few normal tissues can be quantitatively studied from the point of view of cell population kinetics. The two types of tissues best understood are the intestinal epithelium and the hemopoietic system. The kinetics of these two systems are discussed, together with the current models of these cell populations, and the perturbations caused by ionizing radiations are analyzed. (auth)

36390 ELECTROSHOCK SEIZURES AS INDICATOR OF POST-IRRADIATION CHANGES OF THE CENTRAL NERVOUS SYSTEM. Pospisil, E.; Schober, B.; Komenda, S.; Vytrhlik, F.; Srubar, R. (Palacky Univ., Olomouc, Czech.). Strahlentherapie, 135: 234-40(Feb. 1968).

An improved method for the registration of generalized electroshock seizures is described. Electroshock seizures were in four groups of rats three hr and three days after 700 R (in air) of whole body or partial or sham-x-irradiation provoked and all together five parameters of the registered sequence of each seizure were for difference due to the treatment by means of an analysis of variance tested. No statistical significant differences were observed thus strongly supporting previous conclusions that electroshock seizures could not be used as indicators of post-irradiation damage of the central nervous system, and that the latter was either absent or not extensive and of small importance either as a causating factor and/or in the development of the post-irradiation syndrome. Both the present and previous results were compared and discussed in relation to the results and views of other authors. (auth)

36391 DAILY AND YEARLY VARIATIONS IN RADIATION EFFECTS ON RESEARCH ANIMALS AND THE POSSIBILITY OF A PHARMACOLOGICAL INFLUENCE. A SUMMARIZING REPORT. Fochem, Kurt; Michalica, Werner; Picha, Engelbert (Univ., Vienna). Strahlentherapie, 135: 223-6(Feb. 1968). (In German).

The results of whole-body irradiation of normal and tumor-bearing rats and mice at 9 a.m. and 9 p.m. were reported. They demonstrated that a daily rhythm in radiosensitivity existed; the survival of rats irradiated at 9 a.m. was 50% higher. A season influenced rhythm was also observed. The adrenals and their rhythmic secretion of corticoids and 17-ketosteroids were supposed to be the main reason for this difference. The administration of adrenaline, gluco- and hydrocorticoids immediately before irradiation was found to influence this daily rhythm in radiosensitivity. The daily rhythm of radiosensibility in man is discussed. (auth)

36392 RADIATION INJURY AND RECOVERY IN ANAGEN AND TELOGEN RODENT HAIRS. Malkinson, Frederick D.; Griem, Melvin L. (Univ. of Chicago). Radiat. Res., 33: 554-62(1968).

Reduced incorporation of isotope-labeled compounds was studied to assess postirradiation damage and recovery in growing (anagen) and resting (telogen) rodent hairs. Reduced uptake of ^{3}H-DL-serine or ^{75}Se-L-methionine was found to be dose-dependent for hairs in both phases of the cycle. Twofold greater reductions occurred in anagen hairs, as compared to telogen hairs, at given x ray dosages. No recovery of reduced ^{3}H-DL-serine incorporation was demonstrable in telogen hairs up to 12 days postirradiation. In anagen hairs, however, full restoration of normal amino acid uptake occurred in the same postirradiation period. Some implications of these studies for radiation injury and recovery in proliferative and nonproliferative hair matrix populations are discussed. (auth)

36393 EFFECT OF RADIATION ON THE SECRETION OF ADRENOCORTICOTROPIC HORMONE OF THE PITUITARY. Kharitonova, L. V. Dokl. Akad. Nauk SSSR, 176: 946-8(Oct. 1, 1967). (In Russian).

White Wistar male rats were given x-ray doses of 580 and 750 R to the head while shielding the body with a 5 mm layer of lead. The animals were killed by decapitation; the pituitaries were weighed; the anterior portion was separated from the middle and posterior portions, and were placed in acetone for drying. Adrenocorticotropic hormone (ACTH) was extracted from the dried pituitary, and the extract was given intravenously to hypophysectomized recipients at a dose of 25 μg of dried pituitary per 100 g body weight of the recipient. The decrease in concentration of ascorbic acid in the right adrenal gland one hour after injection was taken as a measure of ACTH-activity of the extract. The concentration of ascorbic acid in the left adrenal gland served as a control. The ACTH-activity of the peripheral blood was simultaneously investigated from the functional activity of the adrenals. An increase in the ACTH activity of the anterior pituitary of the irradiated animals was seen from the decrease in ascorbic acid concentration in the adrenals of the hypophysectomized recipients as compared to the controls (– 17% compared to – 10% in the controls). The ACTH concentration in the blood of the irradiated animals was about the same as that of the controls, as shown by the normal concentration of ascorbic acid in the adrenals. (TTT)

36394 EFFECT OF NEUTRON AND GAMMA RADIATION ON ADRENALINE AND NORADRENALINE RELEASE IN THE HUMAN. Goodall, McC. (Univ. of Texas, Galveston). Health Phys., 14: 199-203(Mar. 1968).

The effect of neutron and gamma irradiation on the release of noradrenaline and adrenaline from the sympatho-adrenal medullary system was studied in five subjects from Oak Ridge and two subjects from Los Alamos who had been accidentally irradiated. Daily 24 hr urine samples were obtained for the first 2 weeks, and thereafter at progressively longer periods up to 6 years. The urine samples were assayed for adrenaline and noradrenaline, as was also the adrenal gland of one subject that died. The results showed that the irradiation produced a small and temporary increase in the release of adrenaline, and a marked and prolonged release of noradrenaline, the sympathetic neurohormone. The greater output of noradrenaline than adrenaline suggests that the sympathetic nerves are called into greater play than the adrenal medulla following neutron and gamma irradiation. It seems particularly pertinent that these subjects showed, at 4 and 6 years post-irradiation, a significant increase in the release of noradrenaline. (auth)

36395 RADIATION DOSE TO THE GONADS DURING X-RAY THERAPY WITH A 31 MeV BETATRON. Stromme, A. (State Inst. of Radiation Hygiene, Oslo). Phys. Med. Biol., 13: 117-18 (Jan. 1968).

From the measurements reported it is concluded that, contrary to to common belief, the gonad dose during radiotherapy to the chest using a 31 MeV betatron is at least comparable with, and may be greater than, the gonad dose received in similar treatment with 200 kV x rays. Experimental details are outlined. (UK)

36396 RADIOINDUCED SKELETAL CHANGES IN THE REGION OF THE THORAX AFTER IRRADIATION OF MAMMARY CARCINOMAS. Gregl, Anton; Buechner, Karin; Eydt, Michael; Fichtner, Hans-Joachim; Kienle, Juergen (Univ., Goettingen, Ger.). Strahlentherapie, 135: 269-79(Mar. 1968). (In German).

In a group of 968 patients with mammary gland carcinoma, who underwent radiotherapy within the last 14 years, 18 cases of late skeletal necrosis were noted (1.9% of the patients). An elevation of the frequency of late lesions was found after a dose of 4000 R was given to each field. The spontaneous fractures occurred upon an average of 3.7 years after the end of the irradiation with an increased frequency during the seventies. (auth)

36397 THE EFFECTS OF γ-RAY IRRADIATION ON THE PUPAL MORTALITY AND HATCHABILITY OF THE RICE STEM BORER (CHILO SUPPRESSALIS WALKER). Shim, Jai Wook; Choi, Seung Yoon; Hyun, Jai Sun (Seoul National Univ.). J. Nucl. Sci. (Seoul), 7: 50-55(Oct. 1967). (In Korean).

The effects of gamma-ray irradiation on the pupal mortality and hatchability of the rice stem borer (Chilo suppressalis) were investigated after the pupae were treated. The median lethal doses for pupal mortality were 14.87 ± 1.50 kR for the female and 10.00 ± 0.34 kR for the male. Female pupae were more susceptible than male at lower doses but the susceptibility to the irradiation was reversed with higher doses. There was no remarkable effect on the longevity of the adult moth up to 7 kR irradiation, but the longevity was decreased considerably at 10 kR. Irradiation caused a reduction of the total number of eggs per female. Irradiation greatly reduced the size of the large egg mass with greater than 5 kR when male pupae had been treated, and with greater than 2.5 kR in case of female treatment. The sterile doses (SD-90) were determined as 7.84 ± 0.41 kR in the female and 5.86 ± 0.14 kR in the male. (CO)

36398 URINARY KETOSTEROID EXCRETION AS AN INDEX OF ADRENAL ACTIVITY AFTER WHOLE-BODY IRRADIATION OF RATS AND ITS CORRELATION WITH SURVIVAL. Taceva, J.; Pospisil, M. (Inst. of Biophysics, Brno). Int. J. Radiat. Biol., 13: 289-91(1967).

Urinary 17-ketosteroid excretion was used as an index of the effects of exposure to a single whole-body dose of 800 R x radiation on the activity of the adrenal gland in rats. Early death after irradiation was accompanied by a considerable increase in activity of the adrenal cortex, whereas a low adrenal activity indicated a longer survival time. (C.H.)

36399 EFFECTS OF WHOLE-BODY IRRADIATION AND RADIO-MIMETIC CHEMICALS ON THE ACID RNAse AND PHOSPHODIESTERASE LEVELS OF RAT INTESTINAL HOMOGENATE. Gresham, P. A.; Pover, W. F. R. (Univ. of Birmingham, Eng.). Int. J. Radiat. Biol., 13: 275-8(1967).

The effects of whole-body doses of 160 and 700 R x radiation and of chlorambucil and myleran on acid RNAase and phosphodiesterase levels in rats were determined by analysis of intestinal homogenates prepared at various times after treatment. A dose of 160 R x radiation caused a 50% reduction in RNAase activity 24 hr after exposure, while myleran caused a 20% increase in activity. Whole-body x irradiation caused a decrease of phosphodiesterase activity of 33% at 18 hr after exposure; chlorambucil caused a 30% decrease; and myleran caused a 70% increase in activity. (C.H.)

36400 EVALUATION OF LATE INJURIES AFTER THERAPY WITH FAST ELECTRONS. Lenarduzzi, Guerrino; Valdagni, Claudio; Pozza, Franco; Pistolesi, Gian Franco; Voltolini, Aldo (Univ., Padua). Strahlentherapie, 135: 166-75(Feb. 1968). (In German).

From 1960 until 1965, 787 patients with malignancies were treated by means of fast electron beams (17.5 MeV Siemens betatron). Tumors were localized in the skin (155 cases), the head and neck (335 cases), in the external genitalia (60 cases), the breast (162 cases), and other areas (75 cases). In this series of patients 54 necroses occurred (6.8%) at various time intervals after radiotherapy and were related to the development of late damage from electron beams exposure. In the head and neck region, frequency of necrotic damage was found to be significantly higher (11.0%). In order to identify the causes of the late damage from electrons, evaluations were made for a restricted RBE value for fast electrons of an energy of 10 MeV (testicular atrophy of the mouse), the total dose administered in relationship with the overall time of treatments, and modalities of fractionation. (auth)

36401 EXTRAREGIONAL RADIATION EFFECTS. Krokowski, Ernst (Freie Univ., Berlin). Strahlentherapie, 135: 193-201(Feb. 1968). (In German).

In the studies and description of radiation effects, the local ef-

fects in the irradiated volume were almost exclusively described. There are however also abscopal effects, effects outside the irradiated volume. Among the general reactions one could describe the radiogen protection effect and among the localized effects the so-called symmetry effect and the half-sided radial effect. For the first time a dose-time relationship could be established for the growth inhibition of the bone outside the irradiated volume. Because of the importance of these phenomena, these should be further studied in the laboratory and in clinical practice. Some of these effects could be transmitted by blood. (auth)

36402 THE EFFECT OF PRIOR ULTRAVIOLET IRRADIATION ON X-RAY-INDUCED INHIBITON OF MAMMALIAN DNA-SYNTHESIS. Painter, Robert B. (Univ. of California, San Francisco). Int. J. Radiat. Biol., 13: 293-5(1967).

HeLa cell cultures were irradiated first with a single dose of uv followed by graded doses of x radiation, and the effect on the incorporation of ^{3}H-thymidine into DNA was measured. Results showed that prior exposure to uv radiation did not alter the shape of the x radiation dose-response curve. (C.H.)

Radiation Effects on Plants

Refer also to abstracts 36230, 36231, 36234, 36240, 36241, 36244, 36246, and 36426.

36403 RECOVERY FROM SUB-LETHAL ULTRA-VIOLET DAMAGE IN DIPLOID YEAST. Kiefer, Juergen (Inst. of Biophysics, Giessen, Ger.). Int. J. Radiat. Biol., 13: 399-400 (1967).

Results are reported from a study on the effects of dose fractionation on the recovery of Saccharomyces cerevisiae from sub-lethal uv damage. Results indicated that the population was not homogeneous in respect to sensitivity to a second exposure to uv. About 35% of those cells surviving the first exposure were able to repair sub-lethal damage completely, whereas 65% showed no recovery at all. (C.H.)

36404 FAILURE OF RECOVERY FROM SUB-LETHAL DAMAGE AFTER ULTRA-VIOLET IRRADIATION IN CHLAMYDOMONAS. Hillova, Jana (Inst. of Biophysics, Brno). Int. J. Radiat. Biol., 13: 383-5(1967).

No recovery from sub-lethal uv-induced damage was observed in synchronized cultures of unicellular haploid green algae Chlamydomonas reinhardtii following exposure to fractionated doses. Results are compared with those from similar studies on x radiation-induced sub-lethal damage. (C.H.)

36405 STORAGE AND NITROGEN EFFECTS ON RADIATION DAMAGE IN EINKORN WHEAT SEEDS WITH DIFFERENT WATER CONTENT. Matsumura, Seiji; Mabuchi, Tomoo (National Inst. of Genetics, Misima, Japan). Seiken Jiho, No. 19, 9-17(Dec. 1967).

The effects of water content of seeds, oxygen–nitrogen content of atmosphere, and temperature on the germination rate, seedling growth, and induction of chlorophyll mutations were studied in wheat (Triticum monococcum) following exposure of seed to acute or chronic doses of 10 to 15 kR γ radiation at various dose rates. Chronic irradiation caused inhibition of seedling growth more so than acute irradiation, especially at higher doses. There was no effect of air or oxygen observed on seedling growth, but nitrogen treatment showed a protective effect against inhibition of seedling growth, especially with acute irradiation. No effects of dose, dose rate, oxygen, or nitrogen were observed on seed fertility or the rate of chlorophyll mutations. No decisive decrease in fertility because of storage was found. Growth inhibition was most apparent in dry seeds (6% water content) exposed to higher doses of chronic irradiation. A protective effect of nitrogen treatment was observed at both room temperature and dry ice temperature; low temperature alone afforded some protective effect against radiation damage in seeds. (C.H.)

36406 MICRO IRRADIATION OF SPORES OF COLLETOTRICHUM GLOEOSPOROIDES. Ernst, Dieter; Glubrecht, Hellmut (Technische Hochschule, Hanover). Strahlentherapie, 135: 371-6(Mar. 1968). (In German).

Comparative microbeam irradiations of nucleus and cytoplasm of spores of Colletotrichum gloeosporoides with uv and x rays are reported. The absolute dosimetry of the uv irradiation is described and dose-effect-curves are given. They showed a great difference (factor 6) in x-radiosensitivity between the nucleus and cytoplasm and a small (factor ≤ 2) difference in the uv-sensitivity. For both nuclear and cytoplasmic uv irradiation, greater resistance was found than for the corresponding x irradiation. Mechanisms are discussed. (auth)

36407 RADIORESISTANCE OF F_1 HYBRIDS IN THE TRITICEAE. Boyle, W. S. (Utah State Univ., Logan). Radiat. Bot., 8: 1-6(Feb. 1968).

Potted plants of three F_1 grass hybrids and their respective parents were subjected to acute doses of x-rays ranging from 1 to 8 kR. The hybrids were: Sitanion hystrix × Agropyron trachycaulum, Agropyron cristatum × Agropyron subsecundum, and Agropyron trachycaulum × Hordeum jubatum. As measured by mortality, growth inhibition and dry weight, the hybrids were strikingly and consistently more resistant to the higher dosages of radiation than were their parents or any of the species studied. The radioresistance of the hybrids was not accompanied by unusually low average interphase chromosome volumes, nor by consistent marked increase in rate of growth. The heterozygosity of the hybrids is believed to be associated with their radioresistance in a manner not yet clear. (auth) (UK)

36408 STUDIES ON THE EFFECTS OF RADIATION FROM RADIOISOTOPES INCORPORATED INTO PLANTS. I. THE STIMULATING EFFECTS OF ^{32}P APPLICATION ON THE GROWTH OF BUCKWHEAT. Kim, K. H.; Huh, J. Y.; Park, S. H.; Jung, K. S. J. Nucl Sci. (Seoul), 7: 150-8(Oct. 1967). (In Korean).

Nine levels of ^{32}P ranging from 1.4×10^{-4} to 3.3×10^4 μCi were applied to pots of buckwheat plants three days after germination. At higher levels growth-inhibitory effects were clear in both morphological and quantitative terms. At medium and low levels, some growth-promoting effects were found. At the highest ^{32}P level, about $\frac{1}{4}$ to $\frac{1}{3}$ of the upper leaves and stems began to wither and were rapidly blighted after two weeks. Damage was also found in straw and seed production. No effects were found in fluorescence and maturity. Phosphorus absorption was measured by the level in leaves and total phosphorus production in straw harvested. Phosphorus levels showed the same tendency as other growth indexes. The role of ^{32}P that remains in the soil is discussed. (C.O.)

36409 STUDIES ON THE EFFECTS OF RADIATION FROM RADIOISOTOPES INCORPORATED INTO PLANTS. II. THE INFLUENCE OF INTERNALLY ADMINISTERED ^{32}P ON THE GROWTH OF SOYBEAN, MILLET, AND SALVIA. Kim, K. H.; Cha, J. H.; Kim, T. S.; Park, B. H. J. Nucl. Sci. (Seoul), 7: 65-76(Oct. 1967). (In Korean).

Phosphorus-32 solutions were introduced into stems of pot-grown plants just before inflorescence by means of absorbent cotton thread. Radioactivity levels ranged from 0.65×10^{-4} to 1.09×10^4 μCi/pot. Soybeans showed both stimulative and inhibitory effects in vegetative and reproductive growth. Millet and salvia showed only stimulative effects. Greatest stimulation occurred in salvia root and greatest inhibition in soybean seed weight. Analysis of the growth curve of soybean suggested that both types of growth effects were most conspicuous during the period of most active growth. Retarded linear growth soybean was accelerated during that period and recovered completely by harvest. In plants with stimulated growth no return to normal was shown. It was concluded that soybeans are most sensitive to the radiation, followed by salvia and millet. (C.O.)

36410 STUDIES ON THE EFFECTS OF RADIATION FROM RADIOISOTOPES INCORPORATED INTO PLANTS. III. THE INFLUENCE OF INTERNALLY ADMINISTERED ^{32}P ON THE CONTENTS OF NUCLEIC ACID IN SALVIA LEAVES. Kim, K. H.; Kim, B. M.; Lim, S. K. J. Nucl. Sci. (Seoul), 7: 77-84(Oct. 1967). (In Korean).

The variations in the contents of nucleic acids, nucleoprotein, and total phosphorus in salvia leaves after application of phosphorus-32 at levels ranging from 0.65×10^{-4} to 0.78×10^4 μCi per pot were determined. The role of factors other than the radiation was also considered. (C.O.)

36411 STUDIES OF RADIOSENSITIVITY. VII. DIFFERENCES OF RADIOSENSITIVITY BY TAXONOMICAL RELATIONSHIP IN PLANTS. Bai, Dai Han. J. Nucl Sci. (Seoul), 7: 159-68(Oct. 1967). (In Korean).

More than 20,000 seeds or seedlings of 73 varieties of 41 plants were irradiated under acute x and γ rays, and their LD_{50} in germination and growth are scored in relation to taxonomy radiosensitivity. There were highly significant differences in radiosensitivity among families. However, no distinct differences by variety was scored. For practical purposes, the radiosensitivity can be classified by the taxonomical relationship in plants. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 36184, 36218, 36228, 36229, 36232, 36233, 36236, 36239, 36300, and 36329.

36412 FACTORS OF RADIORESISTANCE OF THE BACTERIAL CELL. Zhestyanikov, V. D. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1460-80(Dec. 1967). (In Russian).

The cell radioresistance depends upon factors affecting primary injury. Dependence of the bacterial radioresistance on the DNA content, on the presence of intracellular radioprotective substances and on reparatory capacity of the cell is discussed. Variations in cell radioresistance of non-related organisms are thought to be determined by different DNA amounts. Different radioresistances of various strains of E. coli cannot be explained by the latter or by different amounts of intracellular radioprotective substances. Susceptibility of E. coli to injury by uv or x radiation appears similar. Recovery is greater in radioresistant strains. An hypothesis is presented that explains variation in cell radiosensitivity in relation to repair mechanisms. (auth)

36413 SENSITIVITY OF THE ESCHERICHIA COLI STRAINS OF GROUP B WITH DIFFERENT ABILITY TO REPAIR RADIATION DAMAGE TO RADIOMIMETICS AND CHEMICAL MUTAGENS. Isabaeva, M. K.; Val'dtstein, E. A.; Zhestyanikov, V. D. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1481-9(Dec. 1967). (In Russian).

Sensitivity of five E. coli B strains of radiomimetics and chemical mutagens was examined. Strains B/r and BγR appeared to be resistant to nitrogen mustard, whereas strains B_{s-1} and $B_{s-1}\gamma R$ were sensitive to this agent, with strain B having an intermediate position. The LD_{50} values calculated for strains with extreme differences in sensitivity were highly different (DRF-75). Strain B/r was resistant to mitomycin C, whereas strains B_{s-1}, $B_{s-1}\gamma R$ and B were sensitive to it (DRF between B/r and B_{s-1} being 13). Strain BγR was a bit more resistant if compared with sensitive strains. Strains B/r, BγR and $B_{s-1}R$ were resistant to methyl methanesulfonate, whereas strain B_{s-1} was sensitive to it, with strain B having an intermediate position (DRF between B/r and B_{s-1} equal to 4). All the strains with the exception of B_{s-1} were resistant to hydroxylamine (DRF-2). Strains B/r and BγR were resistant to nitrous acid, strain B_{s-1} was sensitive to it, whereas strains B and $B_{s-1}\gamma R$ had an intermediate position (DRF between B/r and B_{s-1} equal to 9). The evidence obtained is discussed with regard to the deleterious action of radiomimetics and chemical mutagens. (auth)

36414 SENSITIVITY TO RADIOMIMETICS AND CHEMICAL MUTAGENS OF THE GROUP K12 ESCHERICHIA COLI STRAINS WITH DIFFERENT ABILITY TO REPAIR RADIATION DAMAGE. Isabaeva, M. K. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1490-5(Dec. 1967). (In Russian).

The sensitivities of some E. coli strains belonging to the group K12: AB1157 uvr^+, AB1886 uvr^-, and AB2463 rec^- to the action of methyl methanesulfonate (mms), hydroxylamine and nitrous acid were studied. The strain rec^- appeared to be highly sensitive to mms and hydroxylamine. Strains uvr^+ and uvr^- showed similar sensitivities. This may indicate a certain similarity of the repair mechanism, while the resistance of strain uvr^- may support the fact that the recovery from the action of these agents proceeds without participation of excision enzymes required for repair of the damage caused by uv rays. Strain uvr^- was more sensitive to nitrous acid than uvr^+, whereas the sensitivity of strain rec^- was greater than that of uvr^- strain. A possible role of single breakages of DNA thread, in the deleterious effect of hydroxylamine and nitrous acid is discussed. (auth)

36415 ALTERATIONS IN THE MORPHOLOGY OF BACILLUS SUBTILIS AFTER EXPOSURE TO β-LYSIN AND ULTRAVIOLET LIGHT. Matheson, Audria; Donaldson, David M. (Brigham Young Univ., Provo, Utah). J. Bacteriol., 95: 1892-1902(May 1968).

Viable counts, turbidities, and electron micrographs of Bacillus subtilis exposed to β-lysin and ultraviolet light (uv), singly or in combination, were compared in an attempt to relate death with changes in morphology. The decreases in survival of both the β-lysin- and uv-treated cells were rapid and preceded decreases in turbidity, as well as the changes in morphology. No significant differences were observed in turbidity reduction or morphological alterations of control cells from those of cells exposed to uv light. These cells developed prominent subcell wall spaces during incubation in the hypertonic stabilizing medium. No observable damage in either the cell wall or the cell membrane had taken place during 4 hr, but by 20 hr extensive damage of these two structures was apparent. The control and uv-treated cells exposed to β-lysin did not develop prominent subcell wall spaces. Within 2 hr, lesions were observable in their cell walls, and the cytoplasmic membranes were permeable to phosphotungstic acid. The damage to these structures became more extensive with time. Although the visible changes of control and uv-treated cells were evident much later than those induced by β-lysin, the morphological alterations in all cells were similar. It appeared that β-lysin caused an accelerated release of an autolytic enzyme which digested the cell walls. (auth)

36416 EFFECTS OF DOSE FRACTIONATION ON ULTRAVIOLET SURVIVAL OF ESCHERICHIA COLI. Harm, Walter (Southwest Center for Advanced Studies, Dallas). Photochem. Photobiol., 7: 73-86(Jan. 1968).

Exposure of E. coli B/r and B at low average dose rates of uv radiation (2537 Å), produced either by fractionated doses or by continuous irradiation at a very low dose rate (80 ergs/mm²/hr), results in much increased survival compared to single exposure at high dose rate. This increase is attributed to repair taking place during the irradiation period. The effect is small in the repair-deficient strains E. coli B_{s-1} and C syn^-, and is absent in phage T1 and T4, which cannot undergo repair in the extracellular state. However, the prolonged time available for repair in these experiments accounts for only a very minor part of the increase in survival. The principal factor apparently is that the number of lesions present at any time remains relatively low. Presumably complete repair, not only the excision step, can occur in buffer during the irradiation period. This interpretation is supported by experiments in which cells were exposed to combinations of highly fractionated irradiation and single-dose irradiation. We therefore propose that mutual interference in repair, possibly by overlapping of repair regions in complementary DNA strands, reduces considerably the repair efficiency if many lesions are present. This hypothesis explains the "shouldered" survival curves of B/r and possibly other E. coli strains as owing to decreasing repair efficiency with increasing uv dose. (auth)

36417 MULTIPLE INFECTION BY RNA PHAGES. II. INTERFERENCE WITH fr. Knolle, Peter (New York Univ., N. Y.). Z. Vererb., 98: 270-7(1966). (In German).

Ultraviolet radiation was used to inactivate Escherichia coli fr phages to demonstrate interference with superinfecting phages. Interference was shown to occur between fr and f2 mutants, indicating that the observed effect of mutual exclusion between fr^+ and fr-A 105 is of general nature. Phage lysates, inactivated during storage at 4°, showed strong interference with homologous phages. This phenomenon may explain the temporary immunity of fr-sensitive cells. The uv-inactivated phages interfered with superinfecting viable phages if present at low input multiplicity. This interference showed a maximum of expression immediately upon mixing cells with inactivated phages. During the subsequent 15 min the amount of interference decreased and stayed constant from then on. Cells pretreated with uv-inactivated phages permitted the adsorption of challenge virus, but not its invasion. (BBB)

36418 LYSOGENY IN RHIZOBIUM MELILOTI. Kowalski, Mieczyslaw (Curie-Sklodowska Univ., Lublin). Acta Microbiol. Pol., 15: 119-27(1966).

The frequency of lysogenicity in Rhizobium meliloti and some properties of this lysogenic system were studied. Most strains liberate phages spontaneously, and in a higher titer after uv irradiation. The highest phage titer (2.9×10^9) was reached after 25 sec of uv treatment. In further studies of lysogenicity of other strains, the cultures were irradiated for 30 sec. For phage detection, three indicator strains: L5, L56, and L11 were used because of their wide range of sensitivity. In 33 strains of R. meliloti the presence of phages was detected, and six more phage-carrying strains were found after uv irradiation (L8, L9, L16, L17, L24). These six strains could not liberate phages spontaneously. After uv irradiation, most strains showed an increase of the phage titer (100 to 1000 times). The highest titers (10^9 to 10^{10} phage particles per ml) were obtained in those strains that easily released phages spontaneously. In cultures of some strains, e.g., L7, L54, L56 and L59 the uv irradiation did not induce phage liberation. (BBB)

36419 CELLULAR EFFECTS OF IONIZING RADIATION (CONCLUDED). Little, John B. (Harvard School of Public Health, Boston). New Engl. J. Med., 278: 369-76(Feb. 15, 1968).

Modification of the effects of ionizing radiation on cells and the mechanism whereby cell injury is produced are reviewed. Radiation modifiers are discussed in two classes: compounds offering protection against the effects of radiation and compounds sensitizing cells to irradiation. The nature and importance of recovery and repair processes are considered. They have been well established in bacteria, particularly those occurring after uv irradiation in which specific molecular alterations have been demonstrated. Lethality in cells is the final result of the balance between 2 opposing processes, one involving the production and expression of the initial macromolecular damage, and the other the intracellular repair of this damage before cell division occurs. Eventual survival and apparent radiosensitivity depend not only on the na-

ture of the initial macromolecular defects but also on the probability of their subsequent predivisional repair. In considering molecular mechanisms for radioinjury, two general areas are examined: metabolic changes associated with irradiation which may lead to mitotic failure, and the sensitive target or critical macromolecule in the cell. Several radiosensitive targets or sites of the primary lesion in the cell have been proposed, including DNA, a long-lived messenger RNA, various intracellular fine structures, and cell membranes. Of these, only for DNA is there a substantial body of positive evidence. The enzyme-release hypothesis of radiation damage has not been confirmed and most measurable properties of cell membranes appear quite radioresistant. A discussion for and against implicating DNA as the primary sensitive site in the cell is presented. (BBB)

36420 INADEQUACIES IN RADIOBIOLOGICAL EXPERIMENTS ON MEDIUM EFFECTS. Schubert, Jack (Univ. of Pittsburgh). Int. J. Radiat. Biol., 13: 297-300(1967).

Factors that may influence the results of studies on microorganisms grown on irradiated media are discussed. These include the effects of the oxygen supply during irradiation, the effects of post-irradiation exposure to oxygen, the effects of H_2O_2 content of the media, and the effects of pH during irradiation. (C.H.)

36421 SIMILARITIES IN THE RADIATION RESPONSE OF ESCHERICHIA COLI AND TETRAHYMENA PYRIFORMIS. Calkins, John (Univ. of Kentucky, Lexington). Int. J. Radiat. Biol., 13: 283-8(1967).

Studies on the effects of uv and x radiation on the survival of Escherichia coli and Tetrahymena pyriformis indicated that both organisms possess an activated or induced radiation repair system that is fundamental for both uv- and x radiation-induced lesions. Results are included from studies on mechanisms for repair of radiation injuries and effects of caffeine on radiosensitivity. (C.H.)

36422 A TEMPERED SERRATIA PHAGE WITH SPECIFIC GENETIC INFORMATION ON THE FORMATION OF PHOTOREACTIVATING ENZYME. Pons, F. W. (Univ., Frankfurt am Main). Zentralbl. Bakteriol. Parasitenk., Abt. I Orig., 205: 53(1967). (In German).

On the basis of genetic experiments it was concluded that the Serratia ETA phage contained specific information for the formation of a photoreactivating (PR) enzyme. By the aid of this enzyme uv-induced damage in DNA in the Serratia sigma phage could be repaired. (BBB)

36423 INDUCTION OF, AND RESISTANCE TO THE NUCLEAR AND CYTOPLASMIC POLYHEDROSES IN THE SILKWORM. Aruga, H. Indian J. Sericult., 3: No. 2, 17-26(1964).

The occurrence of cytoplasmic and nuclear polyhedroses was studied under normal rearing conditions, and under the influence of low temperature x rays, and chemicals, with fourth and fifth instar larvae. Favorable nutritional conditions gave rise to the development of nuclear polyhedrosis, whereas, the cytoplasmic polyhedrosis developed under unfavorable nutritional conditions. Implantations of pieces of trachea and adipose tissue of the low temperature treated larvae to healthy pupae showed that the induction and the multiplication of the nuclear virus took place in a part of the refrigerated larvae. X irradiation (19,000 R) of the fifth instar larvae before post-ecdysis feeding induced neither nuclear nor cytoplasmic polyhedrosis. The larvae fed EDTA revealed induced cytoplasmic polyhedrosis. The study of the resistance to polyhedroses revealed that no major genes controlled the resistance to cytoplasmic polyhedrosis in normal strains. F_1 hybrids showed heterosis for resistance to both types of polyhedroses. The resistance to cytoplasmic polyhedrosis was greater than to nuclear polyhedrosis. It was inferred that both types of polyhedral viruses were pre-existent in the organism. (Indian Sci. Abstr.)

Radiosterilization and Radiopreservation

Refer also to abstract 37628.

36424 COMMERCIAL FOOD IRRADIATION: ON THE BRINK. Thro, Ellen. Nucl. News, 11: No. 6, 44-9(June 1968).

Food irradiators sponsored by the Atomic Energy Commission in cooperation with various agencies and institutions are discussed. The following aspects of research in radiation processing of food are reviewed: sprout inhibition, sterilization, disinfestation, pasteurization, disinfection, and product improvement. Radiation processing of meat by Irradco, Inc., is described. Petitions for approval by the Food and Drug Administration are discussed with regard to wholesomeness, bacterial contamination of food, and organoleptic properties. Prospects for the future of food irradiation are reviewed. (H.L.W.)

36425 PROCESS FOR THE PRODUCTION OF TEA. Schroeder, Charles Watt (to Unilever Ltd.). British Patent 1,101,858. Jan. 31, 1968. Priority date Jan. 13, 1966, United States.

Processes for improving the yield of water-extractable matter from tea leaves by irradiation are described. The most useful sources of radiation were gamma rays from radioisotopes or electron beams from accelerators. The irradiated teas were brewed into beverages and compared with regard to flavor, color, aroma, and extractable solids. Tables are presented to show results. (H.L.W.)

36426 STUDIES ON THE PRESERVATION OF FRESH STRAWBERRIES BY MEANS OF γ-RAY IRRADIATION. Harn, Chang Yawl; Kim, Sung Kih. J. Nucl. Sci. (Seoul), 7: 127-33 (Oct. 1967). (In Korean).

Gamma radiation effects on preservabilities among three varieties of strawberries with different storage temperatures were studied. Blackmore, Surecrop, and Sparkle strawberries were irradiated with 100 kr, 200 kR, 300 kR, and 400 kR of γ rays and stored at 4°C and 10°C respectively. Blackmore strawberries were decayed 20.9% in 20 days and Sparkle 22.0%, and Surecrop strawberries were mostly decayed in 12 days when they were stored at 4°C after irradiation with 200 kR. Incidence of decay of Sparkle and Blackmore strawberries was increased about 22.5 to 27.0% when they were stored at 10°C over that at 4°C in 16 days after irradiation with 300 kR. A little preservability was found in Surecrop strawberries with γ radiation. The saccharimeter value of control and irradiated materials during the storage period was showed to decrease gradually without regard to the dosage. The flavor, aroma, and taste of the materials were inclined to decrease according to increase of dosage and extension of storing period. The appearance, texture, and color, of the materials were notably changed at dosage up to 300 kR and according to extension of storing period. (auth)

36427 GAMMA IRRADIATION OF THE TOBACCO BUDWORM: STERILIZATION, COMPETITIVENESS, AND OBSERVATIONS ON REPRODUCTIVE BIOLOGY. Flint, Hollis M.; Kressin, Elaine L. (Metabolism and Radiation Research Lab., Fargo, N. Dak.). J. Econ. Entomol., 61: 477-83(Apr. 1968).

Both sexes of adult tobacco budworms, Heliothis virescens (F.), were completely sterilized by 45 krad of gamma irradiation; 35 krad resulted in less than 1% egg hatch. Sterile females laid about ⅔ as many eggs as the control, and longevity of both sexes was reduced 0 to 10%. The mating ability of males sterilized as adults or pupae was not significantly less than that of the control males in most tests, the females sterilized as adults mated as frequently as the controls. Normally, neither sex mates more than once a night as determined by transfer of spermatophores. Males sterilized as pupae or adults were not fully competitive with untreated males as measured by egg hatch from tests with untreated males and females. However, in a test in which the mating of sterile males was determined by labeling spermatophores with ^{14}C, males were found to be fully competitive in mating females. Females alternately mated to sterile and untreated males usually remained fertile after mating with an untreated male followed by a sterile male, or became fertile about 50% of the time if mated with a sterile male followed by an untreated male. Thus when mating to both types of males occurred, the female was more likely to be fertile than sterile. It was observed also that when second matings altered fertility, the alteration was complete—the result of sperm displacement, not sperm mixing. Sterile males mated to untreated females resulted in about 25% fewer eggs per female than controls. (auth)

36428 FEEDING BY RETICULITERMES sp. ON RADIATION-PROCESSED WOOD-PLASTIC COMBINATIONS. Affeltranger, Charles E. (West Virginia Univ., Morgantown). J. Econ. Entomol., 61: 398-401(Apr. 1968).

Eastern subterranean termites, Reticulitermes flavipes (Kollar), reared under controlled laboratory conditions did not attack wood samples containing polymethyl methacrylate or a co-polymer of polymethyl methacrylate and polymethacrylic acid. They did severely damage wood samples treated with polyvinyl acetate. Termites failed to increase on impregnated wood. The reproduction rate was increased somewhat when they were fed untreated wood and increased still further when they were fed untreated-irradiated wood. Field tests with Reticulitermes sp. at the Wood Products Insect Laboratory, Gulfport, Mississippi, of woods containing polyvinyl methacrylate, and non-treated controls gave comparable results. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

36429 PHYSICAL METALLURGY OF ENGINEERING MATERIALS. Petty, E. R. Institution of Metallurgists–Modern Metallurgical Texts, Volume 6. London, Allen and Unwin, 1968. 322p. 45s.

Properties of the light metals, copper and its alloys, the white metals, alloying metals, iron and steel, and the refractory metals are discussed. Selection of materials for special properties such as ease of fabrication, availability, and low cost are reported. High strength materials, low and high temperature materials, spring materials, wear resistant materials, corrosion and oxidation resistant materials, and materials with special physical properties are discussed. (UK)

Corrosion and Erosion

36430 (BNWL–753) INHIBITION OF STRESS-CORROSION CRACKING WITH PHOSPHATE SOLUTIONS. Larrick, Alvin P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 22p. Dep. CFSTI.

Autoclave tests were conducted for an eight month period to compare the corrosiveness and stress-corrosion cracking inhibition qualities of alternate N Reactor steam generator secondary system water chemistry to that of the zero solids (hydrazine-morpholine) water treatment presently used. Seven tests with phosphate levels from 0 to 1000 ppM, sulfite levels from 0 to 100 ppM, hydrazine levels from 0 to 15 ppM and morpholine levels of 2 ppM were conducted. Stress corrosion cracking of 304 SS tubing obtained from an N Reactor steam generator occurred in both the liquid and vapor phases of solutions not containing phosphates, and in the vapor phase over solutions containing phosphate, but not on samples immersed in the liquid phase of any solution containing phosphate ion. At six months exposure one small 10 mil long crack was noted on a sample in the liquid phase of the solution containing 1000 ppM phosphate, 15 ppM hydrazine; at eight months exposure similar cracks were noted on a sample from this solution and from a sample containing 1000 ppM phosphate, 100 ppM sulfite. Cracks were not found on samples in the liquid phase of three other solutions containing 50 to 100 ppM phosphate. Large cracks were found on samples in the liquid phase of solutions without phosphate and on samples in the vapor phases of most solutions. The phosphate solutions provided cracking inhibition under extremely adverse conditions since the solutions were contaminated with chlorides and oxygen, elements which provide an environment very conducive to stress-corrosion cracking. Stress-corrosion cracking did not occur on other lots of unsensitized 304 SS and 304 SS heat treated similarly to the steam generator tubing nor did it occur on Inconel 600, Incoloy 800 or A212 CS. Weight losses on the stainless steel, Inconel and Incoloy samples were negligible. Total penetration on the carbon steel after 8 months ranged from 0.02 to 0.3 mils in the various solutions. (auth)

36431 (JPRS–45460) EFFECT OF COLD WORK ON CORROSION RESISTANCE OF 2.5 PERCENT NIOBIUM-BEARING ZIRCONIUM ALLOY. Lupakov, I. S.; Rodchenkov, B. S.; Garomova, A. N. Translated from At. Energ. (USSR), 24: 91-4(1968). 8p. CFSTI.

Samples of Zr–2.5% Nb alloy 10 by 40 mm and 1 mm thick were subjected to annealing in the alpha + beta region for 1 hr at 700°C, annealing in the alpha region for 6 hr at 580°C, annealing in the alpha + beta region plus 5, 20 or 40% cold deformation, annealing in the alpha region plus 20% cold deformation by rolling, quenching from the beta region at 960°C plus 20% cold deformation by rolling plus aging at 6 hr at 400 or 580°C, and quenching from the alpha + beta region plus 20% cold deformation by rolling plus aging for 6 hr at 400 or 580°C. Corrosion testing of the coupons was carried out in water vapor at 400°C at a pressure of 100 atm in an autoclave. The results showed that the alloy possessed better corrosion stability in the cold-deformed and quenched states and in cold-deformed and aged states than after annealing in the alpha or alpha + beta regions. A high concentration of niobium in solid solution gave high corrosion stability. (JPRS)

36432 (ORNL-TM–2088) SURVEY OF INFORMATION ON TURBINE BUCKET EROSION. Fraas, A. P.; Young, H. C.; Grindell, A. G. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 96p. Dep. CFSTI.

Experience with erosion in steam, mercury, and potassium vapor turbines has been reviewed. Analytical and experimental investigations of turbine bucket erosion and related processes such as cavitation erosion and damage to targets in ballistics tests are reported. Particular attention is given to a comparison of the erosion experience in steam, potassium, and cesium turbines. The results of the work are summarized in a series of curves and tables. The information assembled has been used as the basis for a set of recommended criteria for vapor turbine designs to be used in a design study comparing the relative merits of cesium and potassium vapor cycles for space power plants. (auth)

36433 PROTECTION AGAINST OXIDATION OF NIOBIUM ALLOYS. Stecher, P.; Lux, B.; Funk, R. (Institut Battelle, Geneva). Entropie, No. 21, 39-65(May-June 1968). (In French).

Two coatings, based on niobium silicide alloyed with titanium and chromium associated with an Sn–Al alloy, were developed. The Sn–Al phase assures the self-healing of local defects. The silicide phase is obtained either by a treatment in a bath or by deposition by the "slurry" method. These coatings were developed with a view to protecting niobium and its alloys against oxidation at temperatures up to 1400°C for long periods. Lifetimes of 300 hr are obtained in case of static oxidation at 1200°C. The coatings withstand 1000 rapid two-minute cycles comprising heating from ambient temperature to 1200°C followed by a cooling down to ambient temperature. The lifetime is shorter when the thermal cycles are longer, about 200 thirty-minute cycles. The failures of the protection are due, on one hand, to the time limited efficiency of the Sn–Al phase because of oxidation and, on the other hand, to diffusion processes within the layers, thereby modifying the structure of the coating during oxidation. A further development of the layers should make possible an improvement of the performance of these coatings. (auth)

36434 KINETICS OF OXIDATION OF DYSPROSIUM METAL IN THE TEMPERATURE REGION 500 TO 800°C. Pethe, L. D.; Mathur, H. B.; Biswas, A. B. (National Chemical Lab., Poona). Indian J. Chem., 6: 156-8(Mar. 1968).

The oxidation of dysprosium metal was studied in the temperature range from 500 to 800°C at an oxygen pressure of 100 torr, by means of an automatic recording volumetric apparatus. The oxidation kinetics can be adequately described by a parabolic rate equation. A plot of the parabolic rate constants versus the reciprocal of the absolute temperature gives a straight line, the slope of which corresponds to an activation energy of 25.8 kcal/mole. An inert radioactive marker of Ag(110) placed at the metal/oxygen interface before oxidation is found at the oxide/oxygen interface. This indicates that the Dy_2O_3 oxide grows predominantly by diffusion of oxygen ions through the oxide. Confirmatory evidence of the diffusion mechanism is obtained from the photomicrograph of the dysprosium metal foil oxidized completely at 800°C. (auth)

36435 HIGH TEMPERATURE OXIDATION OF BERYLLIUM IN WATER VAPOR. Sasabe, Minoru; Nomura, Sueo. Nippon Genshiryoku Gakkaishi, 10: 319-24(1968). (In Japanese).

The effects of water vapor on oxidation of sintered beryllium at high temperatures were studied by measuring the oxidation kinetics of beryllium in water vapor (5 mm Hg and 30 mm Hg) at 600 to 800°C with the use of a Gulbransen type microbalance. At 600°C, the oxidation rate follows the parabolic rate law during the initial period of oxidation, after which it conforms to a new logarithmic pattern. At 650 and 700°C, the oxidation proceeds in two successive steps: first according to the new logarithmic model, and then changing to follow a rectilinear rate law. The latter step is accompanied by breakaway of the oxide film. At 800°C, the oxidation obeyed the rectilinear rate law during the period throughout the course of the experiment. Photographic and electronmicrographic observations of the oxidized beryllium obtained at each stage indicated that the new logarithmic rate law can be attributed to the generation of blisters at the oxide/metal interface, while the ensuing rectilinear pattern is introduced by breakaway of the oxide film, initiated along the grain boundaries through the failure of the blisters. (auth)

36436 CORROSION OF METALS AND ALLOYS. COLLECTION NO. 2. VOLUMES I AND II. Boston Spa, Eng., National Lending Library for Science and Technology, 1967. Vol. 1, 214p; Vol. II, 244p. 21s. 3d. Ea. Pt.

Translation of Korroziya Metallov i Splavov: Sbornik 2 by A. D. Mercer.

New corrosion resistant metals and alloys and corrosion of structural materials by aggressive media in the chemical industry are discussed in Volume I. Volume II covers studies of

protective coatings and corrosion inhibitors. Materials covered include iron, carbon steels, stainless steels, vanadium, titanium, niobium–titanium alloys, aluminum, and aluminum alloys, etc. (UK)

36437 HOW TO PREVENT STRESS-CORROSION CRACKING OF RADIOACTIVE WASTE STORAGE TANKS. Holzworth, M. L.; Girdler, R. M.; Costas, L. P.; Rion, W. C. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Mater. Protect., 7: 36-8(Jan. 1968).

Nitrate stress corrosion cracking caused leakage of several one-million-gallon underground carbon steel tanks storing radioactive waste solutions. Tests showed that the leaks were caused by classical stress corrosion cracking, and were not related to the radioactivity of the wastes. Repair welds and other secondary welds were shown to be particularly detrimental. Corrosion tests are presented that show that full stress relief is the only reliable method of preventing stress corrosion in underground carbon steel tanks containing radioactive waste solutions. The tanks and their contents are described and a metallographic examination of the tank walls is included. No correlation between crack susceptibility and carbon content was noted in the as-welded plates fabricated from 0.08, 0.13, and 0.26% carbon steel. The size of the test samples was an important factor. None of the 4- and 12-in.^{2} plates cracked after 330 days of tests. (BBB)

36438 COMPARISON OF U AND Mo IN IMPROVING THE CORROSION RESISTANCE OF AISI 430 STAINLESS STEEL. Biefer, G. J.; Garrison, J. G. (Canadian Dept. of Energy, Mines, and Resources, Ottawa). Mater. Protect., 7: 39-40(Jan. 1968).

Lab tests in several different corrosive solutions indicated that in ferritic AISI Type 430 stainless steel, alloying additions of 0.24% and 0.55% U resulted in improvements in corrosion resistance. However, somewhat greater improvements generally occurred with additions of 1.02% and 2.03% Mo. The tests were conducted in normal solutions of sulfuric acid, hydrochloric acid, and ferric chloride at 75°F. The Huey test, conducted in 65% boiling nitric acid, resulted in specimen weight losses in 5 successive 48-hr exposures. Weight losses and surface appearances observed after creviced specimens of the steels had been exposed to a 3% sodium chloride solution at 122°F for one week. (BBB)

Preparation and Fabrication

Refer also to abstracts 35978, 35987, and 37541.

36439 (ANL–7365) THE MANUFACTURE OF REACTIVITY-COEFFICIENT ELEMENTS FOR ZERO-POWER REACTOR EXPERIMENTS. Carson, N. J.; Hins, A. G.; Jelinek, H. F.; Ayer, J. E.; Shuck, A. B. (Argonne National Lab., Ill.). Feb. 1968. Contract W-31-109-eng-38. 17p. Dep. CFSTI.

Approximately 17.4 kg of plutonium were fabricated into core plates for 213 plate-type fuel elements to be used in zero-power reactor experiments. The plutonium buttons averaged 22% ^{240}Pu, 4.5% ^{241}Pu, and 0.63% ^{242}Pu. They had sufficient beta, gamma, and neutron activities to make close control of personnel exposure mandatory. The elements were fabricated by a conventional technique that included the following operations: producing billet castings, rolling billets into strips, blanking core plates from the rolled strips, loading core plates into stainless steel jackets, and closure welding. The operations that comprise the fabrication process were chosen to reduce the amount of handling required, since computer programming predicted that a technician could tolerate only 30 min per week of direct handling time. Reduced handling time, close monitoring of personnel exposure, and rotation of personnel between jobs allowed the fabrication to be completed with only minimal use of shielding. (auth)

36440 (EURFNR–473) ISOSTATIC HOT-PRESSING: A NEW POWDER METALLURGY COMPACTION PROCESS. Bumm, H.; Thuemmler, F.; Weimar, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translated from report KFK–708. 22p. (EUR–3717). Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

A description is given of a new type of compaction process for powders, namely, isostatic hot compaction. The process is effected at high temperature and pressures in an autoclave. The specimens are located in a thin-walled metal container which transmits the isostatic gas pressure to the powder, thus bringing it to theoretical compactness. A plant was developed, constructed and tested up to 1600°C and 1000 atm over-pressure. The physical nominal values of some of the specimens hot-pressed were measured and compared with values from the bibliography. (tr-auth)

36441 (NP–17469) CARBIDE MACHINING OF SUPERALLOYS. Galimberti, James M. (Kennametal, Inc., Latrobe, Pa.). [nd]. 22p.

Machining of the superalloys follows general practice with one notable exception—every technique used to produce a finished part must be completely understood, insofar as knowledge of the operation permits. Since many factors are involved and interrelated, the efficiency of the operation is dependent upon a knowledge and control of each factor such as tool geometry, carbide grade, machining conditions, and environment. The influence of these factors and related variables must be recognized and understood. The variables must be kept in proper balance to ensure an efficient operation. The same shop practice applied to the successful machining of the more common alloys must be applied to the superalloys. However, this practice is mandatory if the superalloys are to be machined successfully, efficiently, and even more so, economically. These factors are presented in their proper perspective as an aid in the economical carbide machining of superalloys. (auth)

36442 (ORNL-TM–2208) SOURCES OF CONTAMINATION DURING ELECTRON-BEAM MELTING. Reed, R. E.; Dean, C. W.; McDonald, R. E.; Emery, J. F. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 20p. Dep. CFSTI.

High-purity niobium was electron beam melted and drop cast at a furnace chamber pressure of 5×10^{-6} torr. Before melting, a neutron activation analysis showed: 84 ppM Ta, 4 ppM W, and <1 ppM hafnium. After melting, using a tantalum (T-111 alloy) emitter, the analysis showed: 564 ppM Ta, 50 ppM W, and 413 ppM Hf. At first it was believed that the contamination was coming from the emitter. New batches of niobium were melted using niobium and thoriated tungsten emitters. However, all melts still showed considerable contamination. An investigation revealed that the contamination was being volatilized from the furnace walls by the radiant energy from the beam. After cleaning the chamber, another melt using a T-111 alloy emitter resulted in a metallic impurity content of 115 ppM Ta, 5 ppM W, and <10 ppM Hf. The various sources of contamination during melting are discussed, and the importance of keeping the furnace chamber clean is emphasized. (auth)

36443 CONTACT REACTION OF MOLYBDENUM WITH ZIRCONIUM BERYLLIDE. Panov, A. S.; Rysina, M. M.; Permyakov, L. N.; Vershinin, N. P.; Kornilova, V. P. Izv. Akad. Nauk SSSR, Metal., No. 2, 234-7(Mar.-Apr. 1968). (In Russian).

The contact interaction of Mo with the compound $ZrBe_{13}$ was studied at temperatures between 1170 and 1700°K. At 1170 to 1670°K, the interaction product is the beryllide $MoBe_2$ and at 1770°K $MoBe_2$ and $MoBe_{12}$ are formed. (tr-auth)

36444 ELECTRON FUSION OF MOLYBDENUM IN CONTROLLED GAS MEDIUM. Zagorskaya, T. N.; Ivanovskii, G. F.; Lyakhovich, T. K. Izv. Akad. Nauk SSSR, Metal., No. 2, 132-7 (Mar.-Apr. 1968). (In Russian).

By heating and melting Mo in a controlled gas atmosphere, 2 to 7×10^{-3} wt. % more C is removed from the metal. This purification of Mo from C does not improve the microhardness and the ratio of the electric resistance at room and liquid helium temperature. Repeated processing of the monocrystals in oxygen aggravates these characteristics. (tr-auth)

36445 APPLICATIONS AND DEVELOPMENTS OF CERTAIN SPECIAL METALS. Molinier, R.; Logerot, J. M.; Syre, R. Entropie, No. 21, 79-93(May-June 1968). (In French).

For some years the growing importance of special metals in peak industries has been noted. Among these special metals titanium, beryllium, tantalum, niobium and their alloys already have or may take in the future a choice position. Their production their processing, their characterization in themselves call for advanced techniques in which vacuum metallurgy plays a large part. The physical, mechanical, or technological characteristics of these metals and their alloys make it possible to realize the possibilities of their applications. These applications cover areas as diversified as aeronautics, aerospace, chemical engineering, electro-technics, electronics ... and make it possible to obtain or hope for performances which cannot be given by the more standard materials. Remaining nevertheless "young" metals, they require from their producers and from their users constant and considerable research and development efforts so as to increase the unitary dimensions of the supplied semiproducts, to better master the obtained characteristics, or to adjust them to very specific and new applications. (auth)

36446 APPLICATIONS OF FUNDAMENTAL THERMODYNAMICS TO METALLURGICAL PROCESSES. Proceedings of the First Conference on the Thermodynamic Properties of Materials

held at the University of Pittsburgh, Pa., November 29-30, 1964. Fitterer, G. R. (ed.). New York, Gordon and Breach Science Publishers, 1967. 433p. $26.00. (CONF-641124).

Twenty papers are presented. Separate abstracts are prepared for two. The remaining papers present information on thermodynamics of metallurgical processes not primarily associated with nuclear applications. (J.C.W.)

For abstracts of individual papers see: 36447 and 36473.

36447 PREPARATION OF PURE TUNGSTEN METAL BY REACTION OF TUNGSTEN HEXACARBONYL WITH HYDROGEN AND STEAM OR CARBON DIOXIDE. Ward, J. J.; Coon, A. D.; Oxley, J. H. (Battelle Memorial Inst., Columbus, Ohio). pp 197-220 of Applications of Fundamental Thermodynamics to Metallurgical Processes. Fitterer, G. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.

From International Conference on Applications of Fundamental Thermodynamics to Metallurgical Processes, Pittsburgh, Pa. See CONF-641124.

The thermochemical conditions necessary to deposit high purity tungsten from the hexacarbonyl have been calculated. At temperatures above about 1150°K, there is a wide range of concentration levels in which steam and hydrogen can be mixed with the carbonyl to avoid formation of tungsten oxide and carbide. At lower temperatures, thermodynamic considerations indicate that such high dilutions are necessary that the deposition of pure tungsten becomes impractical. The thermodynamic results were verified by experiments—tungsten deposits containing less than 10 ppM carbon were prepared. The oxygen contents were considerably higher in the 500 to 1000 ppM range, presumably due to atmospheric oxygen sorption on the fine-grained porous coating obtained. (auth)

36448 METHOD FOR PRODUCING HIGH-DENSITY, HIGH-HARDNESS GRAPHITE–THORIUM CARBIDE FUEL ELEMENTS. Oikawa, Takashi (to Showa Denko K.K.). Japanese Patent 1967-15507. Aug. 26, 1967. Filed May 31, 1963.

A method to produce high density, high hardness, fine and uniform thorium carbide distribution in the graphite, non-moisture-absorption fuel elements is presented. Natural graphite is refined at a high temperature, and then powdered to give it a good moldability. A powder of metallic thorium is added. The mixture is placed in a mold of a super heat-resistant alloy, and heated under pressure in vacuum at a high temperature. The molding obtained is fired at 1200°C or above, to carbonize the thorium. (NSA of Japan)

36449 NUCLEAR FUELS FOR THE 70'S. Fortune, R. F. (Canadian General Electric Co., Ltd., Peterborough, Ont.). Engineering, 51: 28-35(May 1968).

The manufacturing sequence of natural uranium fuels used in Canadian reactors is briefly described and the possibilities of using other uranium compounds besides unenriched UO_2 considered. Fabrication costs, thermal efficiency, power density and fuel utilization are examined with supporting illustrative charts. Major engineering challenges to be met, reprocessing problems and some predictions for cost reductions in new fuel cycles are offered. (F.S.A.)

36450 NONAQUEOUS ELECTROPLATING BATH FOR URANIUM. Childs, E. L.; Evans, F. E. (Dow Chemical Co., Golden, Colo.). Plating, 55: 164-7(Feb. 1968).

Uranium is polished anodically at 13 V in a 1.2-ethanediol bath saturated with sodium hypophosphite. The bath must be heated to 90°C to remove water. The operating range is 90 to 110°C. A sample of metal can be degreased and polished without any prior treatment. The surface roughness can be decreased about 60% by the removal of approximately 46 μ of surface in 45 min. (auth)

Properties Evaluations

Refer also to abstract 35994.

36451 (AGN-8284) ALKALI METALS EVALUATION PROGRAM. Quarterly Progress Report, January 1–March 31, 1968. Achener, P. Y. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). June 7, 1968. Contract AT(04-3)-368. 19p. Dep. CFSTI.

CESIUM;RUBIDIUM—Prandtl number of gaseous
LITHIUM—surface tension and contact angle measurements on, with oxygen impurity
ALKALI METALS—thermodynamic and transport properties of, research program on (D.L.C.)

36452 (KAPL-3353) RECRYSTALLIZATION BEHAVIOR OF HAFNIUM. Calhoun, C. D.; Fascia, J. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 1967. Contract W-31-109-eng-52. 31p. Dep. CFSTI.

The recrystallization behavior of hafnium has been investigated. Hafnium hot-worked at 950°C and with an initial average grain diameter of ~55 μ was cold-rolled to reductions of 10, 20, 40, and 60% at 25, 500, and 700°C. The metal was then heat-treated for 10, 30, 60, 100, 1000, and 10,000 min at individual temperatures of 700, 800, 850, 900, and 1000°C. The recovery and recrystallization behavior of the metal was evaluated through hardness measurements, x-ray line-broadening, and metallography. (auth)

36453 (LMEC-Memo-68-10) LIQUID METAL TEMPERATURE MEASUREMENT (SODIUM) STATE-OF-THE-ART-STUDY. Hochheiser, J. S. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). May 31, 1968. Contract AT(04-3)-700. 96p. Dep. CFSTI.

A study of the available techniques and devices for making temperature measurements applicable to liquid sodium cooled nuclear power reactors is presented. Included in this study is a review of the calibration and standards accuracies available, a study of the behavior of matter with temperature and with exposure to liquid metal reactor environments, and a literature survey. A review of the fundamentals of temperature and temperature measurement theory and a list of definitions are included. (auth)

36454 (N-68-15715) EFFECTS ON HYDROSTATIC PRESSURE ON THE MECHANICAL BEHAVIOR OF BODY CENTERED CUBIC REFRACTORY METALS AND ALLOYS. Interim Technical Report. Radcliffe, S. V.; Das, G. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Metallurgy). Dec. 1967. 49p. (NASA-CR-92592). CFSTI.

The pressure dependence of tensile stress-strain behavior of recrystallized powder metallurgy tungsten at room temperature and constant strain rate has been extended to environmental pressures up to 11 kilobars. The substructures developed during plastic straining at high pressure differ with respect to dislocation distribution and density from those for polycrystalline tungsten subjected to similar amounts of plastic strain at higher temperature at atmospheric pressure or single crystals at room temperature. Corresponding to the initiation of plastic yielding, the reduction in area at fracture increases progressively with pressure but with no indication of a brittle-ductile transition up to the highest pressure examined. Fracture occurs by a combination of intergranular and transgranular cleavage over the whole pressure range. At the highest pressure, 11 kilobars, cracks develop but propagate only slowly. The relevance of these various observations to current understanding of flow and fracture in tungsten is discussed. (auth) (STAR)

36455 (NAA-SR-Memo-12554) LITERATURE SURVEY OF HYDROGEN EFFECTS ON NICKEL-BASE MATERIALS. Robertson, W. M. (Atomics International, Canoga Park, Calif.). Sept. 6, 1967. 5p. Dep. CFSTI.

The literature indicates that hydrogen at low pressure can increase the creep rate of nickel-base materials. At high pressure (several hundred atmospheres) and high temperatures, hydrogen can also appreciably reduce the ductility of nickel-base materials. It is concluded that Hastelloy-N, as tested for the S8DR program, should not show any appreciable reduction in ductility due to hydrogen. (auth)

36456 (UCID-15327) HIGH SPEED CATHODIC ETCHER. Steele, Wayne J. (California Univ., Livermore. Lawrence Radiation Lab.). May 9, 1968. 6p. Dep. CFSTI.

The development of a high speed cathodic etcher used in the etching of uranium, uranium alloys, and brazes is reported. By employing recognized techniques and using certain modifications to meet new requirements, it was possible to construct a cathodic etcher having a minimum of variables to control. The new methods developed in handling the samples while within the etching chamber, and controlling temperatures, have greatly improved the entire process. Initial results of these experiments are outlined and discussed. (auth)

36457 (WAPD-TM-767) PREDICTIONS OF TENSILE PROPERTIES AT TEMPERATURES OTHER THAN THE TESTING TEMPERATURE. Goodwin, J. G.; Davis, W. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1968. Contract AT-11-1-GEN-14. 18p. Dep. CFSTI.

A statistical method has been devised whereby the tensile properties of a material at a temperature other than the testing temperature can be accurately estimated by testing at only one temperature. The method involves the establishment of prediction equations over the temperature range of interest and the computation of confidence and tolerance intervals by techniques presented. The tensile properties of Zircaloy-2 are used to illustrate the method; however, the technique is applicable to any material, providing the guidelines cited in the text are observed. (auth)

36458 SOLUBILITY OF ZIRCONIUM IN LIQUID MAGNESIUM AND THE ALLOY ML5. Babkin, V. M. Metalloved. Term. Obrab. Metal., No. 3, 61-4(Mar. 1968). (In Russian).

The solubility of Zr in liquid Mg in the presence of Zn Ce mischmetal, Pb, Ca, Ni, Al, Mn, Si, Sn, Be, and Fe was investigated. It was established that Zn, Pb, Ce mischmetal, and Ca do not affect the solubility of Zr in Mg and contribute to the breaking up of the structure of Mg–Zr alloys, but Ni, Mn, Si, Sn, Al, Be, and Fe reduce the solubility of Zr and roughen the structure. Elements forming with Zr chemical compounds with fusion temperature above 1200°C contribute to the reduction of the solubility of the Zr in liquid Mg. The minimum quantity of admixture of Mn, Si, Sn, Al, Be, and Fe, which is admissible in alloys with Zr, was determined. The joint solubility of admixtures of Zr and Fe in the ML5 alloy in the liquid state was studied. It was shown that solubility of Zr in the alloy decreased with increase of Fe. An effective method for the reduction of the concentration of harmful admixtures of Zr in the ML5 alloy down to 0.0015% was proposed. It was based on the enrichment of the alloy with Fe during superheating up to 900°C and maintenance of this temperature for 30 min. (tr-auth)

36459 DIFFUSION RATES IN INORGANIC NUCLEAR MATERIALS. Dragoo, A. L. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 72A: 157-73(Mar.-Apr. 1968).

The tracer diffusion coefficient, the self-diffusion coefficient, the intrinsic diffusion coefficient and the interdiffusion coefficient are briefly described. Grain boundary and lattice (volume) diffusion are contrasted. The frequency factors (D_0) and activation energies (Q) are tabulated for diffusion in the borides, carbides, and oxides of Be, Hf, Mo, Nb, Ta, Th, Ti, and Zr and for diffusion of C, N, and O in these metals. The purity of the solvent media, the preparation and properties of the samples, the method, the type of diffusion coefficient measured and the temperature range are also specified. (auth)

36460 EFFECTS OF VACUUM ANNEALING AND CARBURIZING ON THE DUCTILITY OF COARSE-GRAINED MOLYBDENUM. Tsuya, K.; Aritomi, N. (National Research Inst. for Metals, Tokyo). J. Less-Common Metals, 15: 245-57(July 1968).

The cause of intergranular brittleness in Mo has been examined by studying the variation in ductility with vacuum annealing, carburizing, and decarburizing, using electron-beam-melted, coarse-grained specimens. The intergranular brittleness could not be reduced by vacuum annealing at 2000°C. A suitable carburizing treatment much improved the ductility; many carbides were observed on the intergranular surfaces in carburized ductile specimens, suggesting that the existence of carbides is not a main cause of the intergranular brittleness. Carburized ductile specimens were embrittled by decarburization in hydrogen. The improvement in ductility resulting from carburizing is thus attributed not only to the deoxidation during the carburizing process but also to the effects of C itself and to dispersion of carbides in matrices. From observations on ageing it is suggested that increase in C segregation at grain boundaries may contribute towards reducing intergranular brittleness. (auth)

36461 HEAT CAPACITY OF $NbFe_2$ AT ELEVATED TEMPERATURES. Rezukhina, T. N.; Drobyshev, V. N.; Tsien, Liu-Ching. Izv. Akad. Nauk SSSR, Metal., No. 2, 215-18(Mar.-Apr. 1968). (In Russian).

The heat capacity of the intermetallic compound $NbFe_2$ was determined at 293 to 1173°K by the mixture method by means of the mass calorimeter. The expression $C_{p\,cal} = 12.90 + 8.11 \times 10^{-3}(T - 293.5)$ was obtained for the mean molar heat capacity. From the relation between the mean and the actual heat capacity for the actual molar heat capacity of $NbFe_2$ in the same temperature interval the expression found was $C_{p\,cal} = 8.15 + 16.22 \times 10^{-3}T$. The additive rule of the heat capacity for $NbFe_2$ was not achieved; significant deviations from the values calculated by the additive mechanism were observed, increasing with reduced temperature. The empirical expression $C_p = 5.34 + 2 \times 10^{-3}T$ (cal/° g-atom) was obtained by comparison of the heat capacity of some metallic compounds reported in the literature. This expression agrees with the experimental data with a precision of ±3 to 4%. It can be used in thermodynamic calculations, in the absence of experimental data, for alloys having principally metallic bonds. (tr-auth)

36462 STUDY OF THE STEPS IN THE RECRYSTALLIZATION OF STRONGLY COLD-WORKED α-URANIUM BY ISOTHERMAL VARIATION OF THE HARDNESS. Ferran, Gustav; Cizeron, Georges (CEN de Saclay, Gif-sur-Yvette, France. Ecole des Mines, Paris). Compt. Rend., Ser. C, 266: 1419-22(May 6, 1968). (In French).

The recrystallization of a uranium of improved purity, previously cold-worked by rolling, was followed by three physical methods. The isothermal curves for the decrease of hardness were interpreted by means of examinations by optical micrography and by diffractometry according to the technique of Barrett. The series of results obtained made possible the explanation of the process taking place in the recrystallization of α-uranium. (tr-auth)

36463 NICKEL- AND COBALT-BASE ALLOYS. Wagner, H. J. DMIC Rev., 5p.(Aug. 11, 1967).

Efforts to predict the sigma-forming tendency in nickel-base superalloys are continuing. New nickel-base superalloys for turbine wheels and buckets are being evaluated. Ultrahigh-strength superalloys for use at 1200°F are being tested and the composition data are tabulated. The processing procedures including extrusion, electroslag melting, and powder metallurgy of superalloys are discussed. A summary of the highest elevated-temperature tensile strengths on thoria-strengthened cobalt-base alloys is given. (J.C.W.)

36464 SINTERING PROCESS. Thuemmler, F.; Thomma, W. (Technische Hochschule, Karlsruhe, Ger.). Met. Rev., Rev. 115, 69-108(1967). (KFK-615).

A review is presented that includes the definition and delineation of the concept of sintering, stages of sintering, possible mechanisms of material transport, and factors affecting material transport. Sintering of multicomponent systems without solubility of the components, with mutual solubility of the components, with the formation of new phases (reaction sintering), with oxide mixtures, and with sintering processes in the presence of a liquid phase is discussed. Hot pressing of large articles is described. A listing of 385 references is included. (J.C.W.)

36465 SURFACES AND INTERFACES. I. CHEMICAL AND PHYSICAL CHARACTERISTICS. Proceedings of the 13th Sagamore Army Materials Research Conference held at Raquette Lake, New York, August 23-26, 1966. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1967. 485p. $22.00. (CONF-660836).

Nineteen papers are included; two have been abstracted separately for NSA. Various aspects of surface kinetics, adsorption and adhesion, interfaces, and the characterization of surfaces were studied. (J.G.B.)

For abstracts of individual papers see: 36466 and 36497.

36466 SURFACE SELF-DIFFUSION IN FCC AND BCC METALS: A COMPARISON OF THEORY AND EXPERIMENT. Gjostein, N. A. (Ford Motor Co., Dearborn, Mich.). pp 271-304 of Surfaces and Interfaces. I. Chemical and Physical Characteristics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1967.

From Conference on Physical and Chemical Characteristics of Surfaces and Interfaces, Raquette Lake, N. Y. See CONF-660836.

New techniques for determining the surface self-diffusion coefficient, D_s, of metals, developed in the last decade, have yielded activation energies, Q_s, ranging from 0.1 to 0.7 of the heat of sublimation and Arrhenius pre-exponential factors, D_o, varying from 10^{-7} to 10^{6} cm²/sec. These discrepancies can be largely removed by analyzing the relative temperature, T_M/T (T_M is the absolute melting point), dependence of D_s. Such a plot for fcc metals revealed that two mechanisms of surface diffusion are operating. The high temperature and low temperature processes are characterized by the following diffusion constants: $Q_s = 30\ T_M$ kcal/mol, $D_o = 740$ cm²/sec, $T/T_M \cong 0.75$; $Q_s = 13\ T_M$ kcal/mol, $D_o = 0.014$ cm²/sec, $T/T_M \cong 0.75$. The terrace-ledge-kink model was used, and it was found that the high-temperature diffusion constants agreed well with the theory for the diffusion of adatoms over terraces. Arguments are advanced to associate the low temperature process with the migration of surface vacancies. The relative temperature dependence of D_s for bcc metals indicates that only one process is operating with diffusion constants: $Q_s = 19\ T_M$ and $D_o = 3.6$ cm²/sec. Very few measurements have been made, however, in the high temperature region where the adatom mechanism is expected to be dominant. These diffusion constants suggest a surface vacancy mechanism for bcc metals. Measurements of the intrinsic adatom diffusivity, D_a, of W by field ion microscopy are discussed; and Q_a is shown to agree reasonably well with the pairwise interaction theory. The correlation of D_s values on a relative temperature scale allows easier identification of impurity effects. These effects are discussed; and mechanisms, by which impurities can either enhance or suppress surface diffusion, are qualitatively developed. (auth)

36467 ZIRCONIUM STRUCTURE. Rubel, H. (to Siemens-Schuckertwerke Aktiengesellschaft). Canadian Patent 782,765, Apr. 16, 1968. Priority date Apr. 11, 1964, Germany.

Properties desirable in the construction material of sheets, tubes and profile rods for a nuclear reactor are obtained by using different zirconium materials, all of which have low-neutron cross sections, in layers. A highly corrosion resistant Zr–Nb 2.5-Cu 0.5 alloy is separated from high strength Zr–Al 1.25–Sn 1–Mo 1 alloy by a hydrogen diffusion-impeding and radiation resistant layer of zirconium oxide. This prevents the brittleness normally associated with the infusion of hydrogen into zirconium structures. Methods for producing the structures are outlined. (F.S.A.)

36468 REFRACTORY COMPOUNDS AS STRUCTURAL MATERIALS: COBALT-BONDED REFRACTORY COMPOUNDS. Morral, F. R. (Battelle Memorial Inst., Columbus, Ohio). pp 229-47 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

The performance of cobalt-bonded refractory compounds for application in structural materials is discussed. Cutting, wear, and hard-facing Stellites and high-temperature, high-strength superalloys containing tungsten, molybdenum, tantalum, and niobium in a cobalt matrix are discussed. The design of cemented carbides containing ~85% WC, Al_2O_3 and MgO bonded by 50% cobalt, and dispersion-strengthened alloys are indicated. Work performed reinforcing a cobalt or cobalt-alloy matrix with refractory-metal or alloy fibers is reported. (J.C.W.)

36469 TECHNOLOGY AND PROBLEMS OF HIGH-TEMPERATURE COATINGS. Wachtell, R. L.; Jefferys, R. A. (Chromalloy American Corp., West Nyack, N. Y.). pp 249-67 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

High-temperature coating materials discussed include aluminides, silicides, beryllides, and ceramic oxides. Coating processes used to apply or form refractory-compound coatings and the sometimes resultant complex systems are explained. Development and production problems are presented. (J.C.W.)

36470 DIFFUSION AND CHEMICAL KINETICS RELATED TO PROBLEMS IN HIGH-TEMPERATURE CHEMISTRY OF THE REFRACTORY CARBIDES. Wallace, Terry C. (Los Alamos Scientific Lab., N. Mex.). pp 133-54 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

Mathematical theory of diffusion in two- and three-component systems is developed and can be applied to systems where data are available. Rules have been developed concerning construction of diffusion paths on a ternary isotherm. A series of alloys of the Ta–W systems were carburized for 6 hours at 2300°C in a methane atmosphere. The isothermal section of the ternary phase diagram is presented. (J.C.W.)

36471 PREPARATION OF REFRACTORY METALS. Nielsen, Ralph H. (Wah Chang Albany Corp., Albany). pp 185-201 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

The simplest method of producing refractory metal compounds of good purity and controlled stoichiometry is by direct combination of the pure elements. A review of the various commercial processes used for the production of the group 4a metals, titanium, zirconium, and hafnium, the group 5a metals, niobium and tantalum, and the group 6a metals, molybdenum and tungsten is given. The principal sources of ores for these and other metals, along with the most important mineral form and an estimate of the free-world reserves are tabulated. (auth)

36472 FUNDAMENTALS OF REFRACTORY COMPOUNDS. Based Upon a Short Lecture Course Presented at the University of California at Los Angeles. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968. 331p.

Twelve papers on the developments in technology, fundamental properties, and the relationship of structure and composition to such properties are presented. An abstract is prepared for each. (J.C.W.)

For abstracts of individual papers see: 35981, 36468–36471, 36498, 36499, 36539–36541, 36547, and 36548.

36473 PARTITION OF METALS BETWEEN LIQUID METAL SOLUTIONS AND FUSED SALTS. Johnson, Irving (Argonne National Lab., Ill.). pp 153-77 of Applications of Fundamental Thermodynamics to Metallurgical Processes. Fitterer, G. R. (ed.). New York, Gordon and Breach Science Publishers, 1967.

From International Conference on Applications of Fundamental Thermodynamics to Metallurgical Processes, Pittsburgh, Pa. See CONF-641124.

The basic thermodynamic relations applicable to the partition of a metal between a multicomponent liquid metal and a fused salt mixture are presented. It is shown that the logarithm of the distribution coefficient may be expressed as the sum of three terms: the first term depends on the standard free energy change for the reaction, the second depends on the composition of the liquid metal, and the third term depends on the composition of the fused salt. The dependence of each of these terms on the appropriate variables is discussed and approximate computational methods suggested. Examples taken from the field of nuclear fuel reprocessing are used to illustrate the use of the equations for practical process development. The very large influence of the liquid metal composition of the partition of a rare earth or an actinide metal between a fused chloride mixture and a reductant-solvent liquid metal solution is emphasized. The use of partition studies for the measurement of the thermodynamic properties of dilute liquid metal solutions is discussed. (auth)

36474 METALS JOINING. Evans, R. M. DMIC Rev., 4p. (Sept. 8, 1967).

A summary of recent developments in metals joining includes data on brazing alloys compatible with tungsten and tungsten alloys. The results of tensile tests at 3990°F of the most desirable alloys are tabulated. Experiments were performed with gas tungsten-arc weld, electron-beam, and thermochemically deposited joining techniques on tungsten and some alloys. Tensile behavior of welds in oxygen-contaminated tantalum alloys T-111, T-222, and niobium alloy FS-35 is recorded. The development of tantalum-alloy-honeycomb panels continues. The new commercial plasma-arc welding process has been evaluated on a comparative basis with gas tungsten-arc welding on sheet alloys. An explosive spot-welding technique is being developed. (J.C.W.)

36475 ADSORPTION OF CESIUM FLUORIDE OF TUNGSTEN. Evans, B. E.; Swanson, L. W.; Bell, A. E. (Field Emission Corp., McMinnville, Oreg.). Surface Sci., 11: 1-8(July 1, 1968).

The ability of fluorine to greatly reduce the work function and increase the thermal stability of cesium on tungsten is demonstrated by these results. Work function values of $\phi = 1.0$ eV, stable up to ~530°K, have been obtained. Migration studies indicate complete dissociation of CsF on adsorption so that surface migration of cesium occurs in the usual range of 150 to 250°K, while fluorine does not become mobile until T > 380°K. Adsorption and desorption of cesium on an F–W layer, formed by impinging CsF on a tungsten surface at 1200°K, are completely reversible leaving the P–W layer unchanged, provided a positive field of 1.8 MeV/cm is applied. However, application of zero or negative fields leads to permanent removal of fluorine during thermal desorption of cesium at ~900°K. For Cs–F–W layers exhibiting values of $\phi < 2.0$ eV and at sufficiently high applied negative fields, the removal of F^- by field desorption occurs. Complete restoration of the slightly field desorbed Cs–F–W surfaces occurs, however, at 115°K. The temperature coefficient of the average work function for the Cs–F–W system is -2.4×10^{-3} eV/deg. (auth)

36476 FIELD-ION MICROSCOPE STUDY OF THIN FILMS OF IRIDIUM ON MOLYBDENUM. Whitmell, D. S. (Atomic Energy Research Establishment, Harwell, Eng.). Surface Sci., 11: 37-51 (July 1, 1968). (AERE-R-5608).

The deposition of thin films of iridium on molybdenum has been studied by field-ion microscopy. When the substrate was held at low temperatures during and after deposition, a localized thin deposit coherently bound to the substrate was formed. At higher substrate temperatures, diffusion of the iridium took place, and thicker films were grown epitaxially on the substrate with (111) Ir ∥ (110) Mo and [10$\bar{1}$] Ir ∥ [1$\bar{1}$1] Mo. Twin crystals caused by multiple positioning, and stacking faults, were found. There was no evidence of alloying by surface diffusion. (auth)

36477 DISSOCIATIVE ELECTRONIC DESORPTION OF CARBON MONOXIDE FROM TUNGSTEN. Coburn, J. W. (Univ. of Minnesota, Minneapolis). Surface Sci., 11: 61-81(July 1, 1968).

A tungsten surface covered with adsorbed CO molecules has been subjected to low energy electron bombardment. A current of O^+ ions originating at the bombarded surface was observed but no C^+ or CO^+ ions were seen. The experimental structure permitted the observation of either the O^+ surface ion current or the gas-phase CO^+ ion current as the tungsten surface temperature was increased at a controlled rate. These thermal desorption spectra did not align with each other on the temperature axis in the expected way, and in order to explain this observation it is suggested that the electronic desorption efficiency is not a constant for CO molecules adsorbed in a specific type of site. The dependence of the O^+ current on the electron energy, the electron current density, and the CO pressure has been determined. An approximate energy distribution of the O^+ ions has been measured and values for the energy threshold, the minimum kinetic energy of the desorbed O^+ ions, and the average efficiency for the production of

an O^+ ion were also obtained. An electron-bombardment-induced O^+ current which increases with increasing surface temperature has been observed for surface temperatures between 1000 and 1300°K. (auth)

36478 THERMODYNAMICS OF THE ERBIUM–DEUTERIUM SYSTEM. Lundin, Charles E. (Univ. of Denver). Trans. Met. Soc. AIME, 242: 1161-5(June 1968).

The character of the Er–deuterium system was established by determining pressure-temperature-composition relationships. A Sieverts' apparatus was employed to make measurements in the temperature range, 473 to 1223°K, the composition range of erbium to ErD_3, and the pressure range of 10^{-5} to 760 torr. The system is characterized by three homogeneous phase regions: the metal-rich, the dideuteride, and the trideuteride phases. These phases and their solubility boundaries were deduced from the family of isotherms of the system which relates the pressure-temperature-composition variables. The equilibrium plateau decomposition relationships in the two-phase regions were determined from van't Hoff plots to be: $Er_{ss} + ErD_2$: $\log_{10}p(\text{torr}) = (-11{,}570 \pm 40/T) + 10.81 \pm 0.04$. $ErD_2 + ErD_3$: $\log_{10}p(\text{torr}) = (-4380 \pm 30/T) + 9.66 \pm 0.05$. The differential heats of reaction in these two regions are $\Delta H = -53.0 \pm 0.2$ and -20.0 ± 0.1 kcal per mole of D_2, respectively. The differential entropies of reaction are $\Delta S = -36.3 \pm 0.2$ and -31.0 ± 0.2 cal per mole D_2·deg, respectively. Relative partial molal and integral thermodynamic quantities were calculated from the pure metal to the dideuteride phase. (auth)

36479 LATTICE PARAMETER AND THERMAL EXPANSION COEFFICIENT OF MOLYBDENUM BETWEEN 15° AND 65°C. Straumanis, M. E.; Shodhan, R. P. (Univ. of Missouri, Rolla). Trans. Met. Soc. AIME, 242: 1185-6(June 1968).

Lattice parameters of molybdenum of various purities are tabulated for previous and present determinations. Measurements under controlled conditions using high-purity Hilger molybdenum powder (containing 0.0015 wt % of Fe, 0.005 of Si, and traces of other elements) and a 99.95% pure preparation (containing Cr, Fe, Ni, Si, Sn, and C in amounts of 50 ppM of each and smaller amounts of Cu, Pb, Mg, and Mn) were performed. (J.C.W.)

36480 AGING CHARACTERISTICS OF AN Fe–11 AT. PERCENT Mo ALLOY. Rawlings, Rees D.; Newey, C. W. A. (Imperial Coll. of Science and Tech., London). Trans. Met. Soc. AIME, 242: 1001-7(June 1968).

The aging characteristics of an Fe-11 at. % Mo alloy have been studied by means of light metallography together with density, Young's modulus, and hardness measurements. The results were consistent with the precipitation of a single intermetallic compound during aging; overaging was slow relative to that in other iron-based binary alloys. The solution treatment temperature had a small effect on the rate of hardening whereas deformation prior to aging had a marked effect on both the rate of hardening and the peak hardness. The density data indicate that the compound precipitated is Fe_3Mo_2 and not the Laves phase Fe_2Mo. Analysis of the modulus and density results gave values for the time exponent for precipitate growth of approximately 1.0 and 1.5 for the alloy aged with and without prior deformation, respectively. (auth)

36481 EFFECTS OF HYDROGEN CONTAMINATION ON THE WORK FUNCTION OF URANIUM ON TUNGSTEN. Collins, R. A.; Blott, B. H. (Univ. of Southampton, Eng.). Surface Sci., 11: 149-52(July 1, 1968).

Measurements on the effects of hydrogen adsorption on uranium-coated tungsten field emitters are reported. Measurements were performed by depositing up to 12 monolayers of U onto a W field emitter. Hydrogen was then leaked in at a controlled rate. Data were compared with previous performances of similar experiments. It is concluded that the surface potential of hydrogen on U is dependent upon the thickness of the evaporated U layer, and that the structure of the U surface determines the state of binding of the hydrogen on the surface: ionic bonding and higher surface potentials occur for U deposits of more than a few monolayers. (J.C.W.)

36482 DISSOCIATIVE CHEMISORPTION OF CARBON MONOXIDE ON HOT TUNGSTEN. Kawasaki, Koji; Senzaki, Kiyoshi; Sato, Mieko (Electrotechnical Lab., Tokyo). Surface Sci., 11: 143-6(July 1, 1968).

The adsorption process of CO on hot W by a pulsed field emission microscope was investigated. The adsorption of CO on hot W has unusual characteristics. The background pressure was kept in the order of 10^{-10} torr. The electrolytically etched tungsten tip was cleaned thermally about 2200°C and CO was admitted to the field emission tube. The pulsed field of 14 kV with 800 cps and pulse width of 1 μsec was applied on the tip. Field emission patterns of W at 650°C as a function of exposure time to gaseous CO at a pressure of 2×10^{-7} torr are presented and also the adsorption patterns of CO on W at 800°C. It is concluded that CO is dissociative on a hot W surface, and at least CO in β_1 and β_3 states is dissociative on tungsten. (J.C.W.)

36483 THE METALLURGY OF COBALT ALLOYS: A 1968 REVIEW. Morral, F. R. (Battelle Memorial Inst., Columbus, Ohio). J. Metals, 20: 52-9(July 1968).

Hexagonal close-packed cobalt-base alloys, if they can be achieved at the required temperatures, could have very desirable creep-strength properties in addition to good wear resistance and low coefficient of friction. The advantage imparted by the 70° higher melting temperature of cobalt over nickel has as yet not been exploited. Better knowledge of the effect of the various elements present in very small amounts in cobalt and its alloys is still needed. Hardening of the cobalt-base alloys essentially by a method other than by precipitation of carbides, although investigated to some extent, has not as yet given satisfactory results. This may be due to the limited knowledge of the metallography of cobalt alloys. The effect of precipitate or dispersoid on the properties of the material, assuming the very strongest solution-strengthened cobalt matrix is used, will depend not only on the morphology (size, shape, and orientation) but also on stability of these particles. The results of the work on TD-Co alloys are encouraging. The cobalt-base alloys present an interesting challenge, since there are several possible approaches to improving them. (auth)

36484 STAINLESS STEEL AND NICKEL BASE ALLOYS FOR SUPERHEATER ELEMENT CLADDING. Oestberg, G. (Aktiebolaget Atomenergi, Stockholm). Atomwirt. Atomtech., 10: 242-4(May 1968). (In German).

A report is given of results which have been obtained during the last two years in out-of-pile investigations on mechanical properties and corrosion. Information relating to the selection of a cladding material is reported. Pure ternary Fe–Cr–Ni alloys, 18/11, 20/25, 20/25 Nb, 20/35 and 16/75, have yielded satisfactory ductility values in tensile or creep tests even after thermal treatments that usually seriously decrease the ductility of similar but stronger alloys, namely Inconel 625. For the proposed steam-cooled fast reactor, strength is of primary interest in addition to ductility. Pending operating experience of fuel elements under conditions typical of this type of reactor, various assumptions have been made about the combined requirements of strength and ductility in creep. The studies on corrosion resistance include pitting corrosion, stress corrosion cracking in liquid or moist environment, general oxidation, and localized stress assisted attack in high-temperature steam. In the Marviken reactor, the steam entering the superheater channels contains moisture. In the fast steam-cooled project this condition, which enhances pitting and stress corrosion, is thought to be less severe, while the requirements of high resistance to oxide formation are greater due to the closer dimensional tolerances and the higher cladding hot spot temperature than in Marviken (670°). As a compromise with regard to neutron economy and to all the different corrosion effects described, as well as to the mechanical properties, it is suggested that for the Marviken superheater element cladding 20/35 or 20/25 (Nb) should be recommended. For the steam-cooled fast project the same base alloy but with strengthening additions of Ti, Mo and B is thought to be feasible. (auth)

36485 ZIRCALOY-STEEL BONDS FOR BOILING-SUPERHEATER FUEL ELEMENTS. Eisfelder, H.-J.; Francke, K. P.; Weidinger, H. G. Atomwirt. Atomtech., 10: 245-8(May 1968). (In German).

Nuclear steam superheating, because of the heightened thermal and mechanical stressing of the fuel elements as compared with boiling water reactors, led to new requirements on the materials for the canning and closures of fuel rods. Austenitic steel and nickel-based alloys are utilized for the canning tubes of fuel elements for integrated boiling-superheater reactors involving nuclear superheating of the saturated steam produced from the reactor water. In an integrated boiling-superheater reactor, saturated steam is generated in the outer jacket of a tubular fuel rod and then superheated in the inner casing of the rod. This makes it necessary to bond the canning material Zircaloy on the boiling side with austenitic steel on superheating side. The different thermal coefficients of expansion of these two materials as well as the differing operating temperatures in the outer and inner jackets lead to very high mechanical stresses at the bonding. The problem therefore arises of developing a bond which, despite the considerable differences in metallurgical and mechanical properties between Zircaloy and austenitic steels, will withstand the severe mechanical and thermal stresses of reactor operation and which will not compromise the mechanical integrity of such a combined boiling-superheater fuel element. Zircaloy-2 and the austenitic steel 18/8-Cr/Ni (AISI 304) form the basis of the specifications. Zircaloy-steel duplex tubes were developed for the

bonding of Zircaloy with austenitic steel and from which mechanically stable and gas-tight end plugs for tubular fuel rods were manufactured. The bonding was obtained by common heat forming of these materials by extrusion and, with a structure having Zircaloy as the outer tube, is backed up by supplementary mechanical cramping. The bonding was tested under simulated reactor conditions. All the trials (including tensile and shear testing, thermal cycling and alternating load tests) served to demonstrate the very satisfactory mechanical and thermal stability of the Zircaloy-steel bonding. (auth)

36486 EMITTANCE OF URANIUM OXIDES. Held, Peter Christian. Contract W-7405-eng-82. Iowa City, Iowa, Iowa State Univ., 1967. 67p. (IS-T-181).

Thesis.

Hemispherical spectral emittances were measured for uranium oxides. The compositions ranged from $UO_{1.95}$ to $UO_{2.29}$, the densities from less than 8.0 to more than 10.6 g/cm³, the porosities from less than 0.5 to more than 19.0%, and the temperatures from about 450 to about 2400°K. The data were taken at 0.656 and 0.70 μ wave lengths. It was found that the emittance in all cases is high, ranging from about 0.70 to 0.88. The emittance was not found to be systematically sensitive to temperature, porosity, density, or surface finish and to be only slightly sensitive to stoichiometry. The high emittance values are linked to the absorption edge observed for uranium oxides in the visible portion of the spectrum. A more refined analysis of the absorption mechanism must await a resolution of the fine structure in the absorption edge. (Disser. Abstr.)

36487 MICROSTRESS CHARACTERISTICS OF DUCTILE AND BRITTLE MOLYBDENUM. Turk, Charles David. Ithaca, N. Y., Cornell Univ., 1967. 128p.

Thesis.

The microplastic properties of arc-cast, TZM, and powder metallurgical molybdenum sheet were investigated in tension at room temperature. Plastic strains of 1×10^{-6} in./in. to 1×10^{-4} in./in. were measured using resistance strain gage techniques. Grain sizes were varied in order to establish a ductile-to-brittle grain size transition. A two stage microstrain curve consisting of a region of high work hardening and one of dynamic recovery resulted for the arc-cast molybdenum, while only a single stage was evident for the powder metallurgical TZM molybdenum. The coarse-grained brittle samples exhibited less work hardening in the microstrain region and lower microyield points. Increasing the strain rate of the arc-cast molybenum suppresses the first stage of work hardening. The transition in the work hardening in the microstrain region supports work of other investigations in which it is postulated that the transaction stress represents the stress at which cross-slip is initiated. (Disser. Abstr.)

Structure and Phase Studies

Refer also to abstracts 35981, 36465, and 37047.

36488 (COO-1198-518) STRUCTURE OF THE ANOMALOUSLY BRIGHT ATOMIC GROUPINGS SEEN IN FIELD ION MICROGRAPHS. Tong, H. C.; Gilman, J. J. (Illinois Univ., Urbana). June 1968. Contract AT(11-1)-1198. 12p. (CONF-680611-1). Dep. CFSTI.

From 4th International Materials Symposium on the Structuure and Chemistry of Solid Surfaces, Berkeley, Calif.

The fine structures of the bright image groups along [100] zonal lines of tungsten field-ion micrograph were successfully resolved. Most of the groupings are triplets. Quadruplets and quintuplets were also found. It is suggested that each multiatomic spot is a single molecular unit bound together by the presence of the imaging field. The induced polarization energy stabilizes these units at metastable sites of relatively low coordination number. (auth)

36489 (GEAP-5503) GRAIN BOUNDARY STUDIES OF AUSTENITIC STAINLESS STEELS. Armijo, J. S. (General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center). Sept. 1967. Contract AT(04-3)-189. 20p. (EURAEC-2035). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The problem of intergranular cracking of austenitic stainless steel fuel cladding (which was free of grain boundary carbides or second phases) in high temperature boiling water reactor environments prompted detailed studies of grain boundaries in austenitic stainless steels. The techniques used included grain boundary microhardness measurements, grain boundary thermoelectric measurements, and grain boundary polarization measurements. The grain boundary thermoelectric measurement technique was developed but did not reveal differences between grains and grain boundaries in austenitic stainless steels. The microhardness and polarization experiments did demonstrate differences between grains and grain boundaries. The grain boundaries were sometimes found to be harder than the grains. The grain boundaries yielded markedly different polarization data which were qualitatively in agreement with the observed intergranular corrosion behavior. A model was developed from the grain boundary studies and from corrosion test results which describes the effects of various variables on the intergranular corrosion susceptibility of nonsensitized austenitic stainless steels. The model is based on the phenomenon of equilibrium solute segregation at grain boundaries and suggests that elemental impurities are segregated at grain boundaries in commercial austenitic stainless steels. This segregation occurs without precipitation, and should not be confused with the phenomenon of sensitization. When an alloy is exposed to a highly oxidizing solution, the grain boundaries (which are chemically different from the grain faces) become preferred sites of metal dissolution. If impurities which are commonly present in stainless steel (such as silicon or phosphorus) are removed from the alloy, it is no longer susceptible to intergranular corrosion. (auth)

36490 (JPRS-45470) INFLUENCE OF CONDITION OF IMPURITIES ON STRAIN ORIENTATION IN LOW-ALLOYED ALPHA URANIUM. Ivanov, V. E.; Zelenskiy, V. F.; Kunchenko, V. V.; Royenko, N. M.; Krasnorutskiy, V. S.; Ashikhmin, V. P. Translated from At. Energ. (USSR), 24: 87-91(1968). 13p. CFSTI.

Uranium samples pressed at the temperature of the gamma phase were annealed at 800°C for 3 hr and quenched from the beta phase in water with subsequent annealing at 600°C. Other samples were quenched directly from the beta phase in water with subsequent annealing at 130, 550 and 600°C. The samples were then drawn at a rate of 0.4 m/min with a total reduction in area of 54 to 59% after 4 to 5 passes. The samples contained 0.03 wt % Fe and Si, <0.1 % C, and 0.005 and 0.07 wt % Al. These impurities exceed the solubility limit in the alpha uranium phase, and they should precipitate out as finely dispersed particles on quenching from the beta phase. Three samples were taken from each rod and subjected to x-ray analysis. From the intensities of the diffracted lines the density of pole figures and the growth index G_x were calculated by computer. Annealing of the samples and increasing the deformation temperature led to an increase in pole density along the (110) direction, and to a decrease in the growth index G_x. (JPRS)

36491 ALLOYS OF CERIUM WITH NEODYMIUM, SAMARIUM AND TERBIUM, AND OF PRASEODYMIUM WITH TERBIUM. Speight, J. D.; Harris, I. R.; Raynor, G. V. (Univ. of Birmingham, Eng.). J. Less-Common Metals, 15: 317-30(July 1968).

The lattice spacings of a selection of alloys in the systems Ce-Nd, Ce-Sm, Ce-Tb and Pr-Tb, have been determined. For the Ce-Nd, Ce-Tb and Pr-Tb systems, the room-temperature magnetic susceptibilities of certain alloys have been determined. Extrapolation of the atomic volume/composition plots of alloys with the double hexagonal structure in the Ce-Nd, Ce-Sm and Ce-Tb systems to 100 at.% Ce indicates that the apparent atomic volume of Ce in these alloys exceeds that of β-Ce, and that this atomic volume corresponds to an effective valency of 3 for the Ce atoms. In the close-packed hexagonal, Tb-rich, Ce-Tb alloys, the Ce atoms again appear to be in an expanded form corresponding to a valency of 3. These results are discussed in terms of the tendency for Ce to adopt the same valency as that of the solvent metal. (auth)

36492 OCCURRENCE OF THE MX_2 PHASES OF THE RARE EARTHS WITH THE IB, IIB, AND IIIB GROUP ELEMENTS AND THEIR CRYSTAL STRUCTURES. Iandelli, A.; Palenzona, A. (Univ., Genoa). J. Less-Common Metals, 15: 273-84(July 1968).

Intermetallic compounds of the rare earths (R.E.) of $R.E.X_2$ compositions with the metals of the IB, IIB and IIIB Group of the Periodic System have been studied structurally. The occurrence of the observed structure types appears to be related mainly to the dimensions of the two atoms involved, but other factors, such as the electronegativity and the valency need to be taken into consideration. For the trivalent rare earths, lattice dimensions or interatomic distances and cube roots of the unit formula volumes decrease linearly with their ionic radii, as in other series of isomorphous compounds. Magnetic susceptibility measurements indicate that, excepting $YbAu_2$, Eu and Yb behave as divalent elements, similar to the alkaline earths. (auth)

36493 POLYTHERMAL CROSS SECTIONS OF Mo-Ti-Zr CONSTITUTION DIAGRAMS. Zakharova, M. I.; Prokoshkin, D. A. Izv. Akad. Nauk SSSR, Metal., No. 2, 219-23(Mar.-Apr. 1968). (In Russian).

On the basis of x-ray structural and microstructural analyses and of measurements of hardness and microhardness of samples quenched from the equilibrium state at 600, 750, 800, 900, 1200, and 1400°C, the results of thermal analysis and determination of the solidus surface by optical methods, polythermal cross sections of Mo–Ti–Zr system with 10, 20, and 30 at. % Ti were constructed. The peritectic reaction liquid + $\beta_1 \rightleftharpoons \beta_2$ + S occurs in the ternary Mo–Ti–Zr system at 1575°C. Alloying Mo with Ti and Zr significantly reduced the fusion temperature of Mo. Alloying Ti and Zr with Mo stabilizes the β-phase with respect to the low-temperature modification of the α-phase. The range of the α-phase exists only on the polythermal cross section at 10 at. % Ti between 600 and 680°C, and on the Zr–Ti side is dispersed no more than up to 0.3 at. % Mo. To the extent of the increase of the content of Ti in the polythermal cross section of the diagram, the range of the homogeneous state of the β solid solution (β, β_1, β_2) is increased, during which, at the greatest Ti content of 30 at. %, there is a range of uninterrupted series of solid solutions above 1450°C. (tr-auth)

36494 ELECTRONIC STATE OF CERIUM IN SOME PALLADIUM ALLOYS. Harris, I. R.; Norman, M. (Univ. of Birmingham, Eng.). J. Less-Common Metals, 15: 285-98(July 1968).

The room temperature lattice spacings of Pd–La, Ce, Pr and Y alloys and the magnetic susceptibilities over a range of temperatures of Pd–Ce and Pd–Y alloys, have been measured. The lattice spacings indicate that there is a small solubility of La and Pr in α-Pd whereas Ce and Y dissolve up to approximately 12 at. % at 900°C. The lattice spacings and magnetic susceptibility results also indicate that the effective valency of the Ce atoms in the α-Pd solid solutions is close to that of α-Ce whereas, in the LI_2-type phase, $CePd_3$, the effective valency of Ce is slightly in excess of that characteristic of γ-Ce. (auth)

36495 PLUTONIUM IN FAST NUCLEAR REACTORS. VI. APPENDIX. Bucci, Pompeo. Ing. Nucl., 8: No. 6, 33-77(Nov.-Dec. 1967). (In Italian).

Tables, graphs, and phase diagrams on the properties of Pu are presented. The characteristics of the systems Pu–Al, Pu–Be, Pu–Hg, Pu–Cr, Pu–Mo, Pu–Nb, Pu–Ta, Pu–W, Pu–V, Pu–Fe, Pu–O, Pu–Th, Pu–H, Pu–U, and Pu–Zr are discussed and shown in graphic form. (J.S.R.)

36496 SUPERCONDUCTIVITY AND LATTICE PARAMETERS IN FACE-CENTERED CUBIC Pt–W AND Pd–W SOLID SOLUTIONS. Luo, H. L. (Univ. of California, San Diego, La Jolla). J. Less-Common Metals, 15: 299-302(July 1968).

With the liquid quenching technique adapted to an arc furnace, face-centered cubic solid solutions of Pd and Pt have been retained up to 44 and 67 at. % W, respectively. Minima in the lattice parameter vs. composition curves are observed at 10 at. % W–Pd and 18 at. % W–Pt. Alloys in the composition ranges 26 to 44 at. % W–Pd and 28 to 67 at. % W–Pt are superconducting. (auth)

36497 ELECTRON OPTICAL CHARACTERIZATION OF METAL SURFACES. Sewell, Peter B.; Cohen, Morris; Mitchell, Don F. (National Research Council, Ottawa). pp 53-76 of Surfaces and Interfaces. I. Chemical and Physical Characteristics. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Syracuse, N. Y., Syracuse University Press, 1967.

From Conference on Physical and Chemical Characteristics of Surfaces and Interfaces, Raquette Lake, N. Y. See CONF-660836.

The techniques of conventional electron microscopy and reflection electron diffraction were used to obtain information about the crystalline microstructure and chemical composition of surfaces. Under favorable circumstances surface contamination at the level of 10^{-8} cm^{-2} was detected by these methods. To explore the possibility of examining clean-surface phenomena by reflection high-energy-electron diffraction, an ultrahigh vacuum diffraction apparatus was constructed. Surface monolayer processes were observed by high-energy-electron diffraction. This approach to the examination of surfaces is discussed in relation to the preparation and properties of low index surfaces on single crystals of iron, nickel, and tungsten. (auth)

36498 CRYSTAL STRUCTURES OF REFRACTORY CARBIDES AND NITRIDES. Bowman, Allen L. (Los Alamos Scientific Lab., N. Mex.). pp 49-65 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

Experimental determination of crystal structures utilizes beams of x-rays, neutrons, or electrons. The equipment and techniques applied are stated. Three-dimensional pictorials or two-dimensional plane projections are used to describe specific structures. The structures of carbides and nitrides are described. Perspective drawings of TaC, Nb_2C, WC, TaN, Y_2C, UC_2, and ThC_2 are included. (J.C.W.)

36499 BASIC RELATIONSHIPS INVOLVING PHASE BOUNDARIES AND HOMOGENEITY RANGES OF NONSTOICHIOMETRIC COMPOUNDS IN REFRACTORY BINARY AND TERNARY SYSTEMS. DePoorter, Gerald L.; Wallace, Terry C. (Los Alamos Scientific Lab., N. Mex.). pp 1-15 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

Variation of thermodynamic properties across a solid single-phase region is summarized for refractory binary and ternary systems. Phase diagrams are described and constructed. Relative stabilities of compounds are directly related to the activities of the components in the compound. (J.C.W.)

36500 COMPUTER AID IN INDEXING Hcp FIELD-ION MICROGRAPHS. Sproul, W. D.; Richman, M. H. (Brown Univ., Providence). Trans. Met. Soc. AIME, 242: 1186-7(June 1968).

In order to index field-ion micrographs of hcp metals, angles between various planes must be computed. Work was done to identify the structure and index the orientation of field-ion micrographs of the compounds WC and W_2C. To simplify the calculations, a program was written in FORTRAN IV for use on the IBM 360, Model 50 which will compute all angles between planes with indices (h_1 k_1 l_1) and (h_2 k_2 l_2) in the range from ($\bar{4}$ $\bar{4}$ 4) to (4 4 4) for any given c/a ratio. A computer-derived projection for WC with the ($\bar{2}$ 1 1 2) pole in the center is shown and the angular relations used to construct the projection are tabulated. (J.C.W.)

36501 YTTERBIUM–ZINC PHASE DIAGRAM. Mason, J. T.; Chiotti, P. (Ames Lab., Iowa). Trans. Met. Soc. AIME, 242: 1167-71(June 1968). (IS–1721).

Thermal, x-ray, metallographic, and resistivity data were obtained to establish the phase diagram for the Yb–Zn system. Six intermetallic compounds and five eutectics have been identified. The compounds YbZn, $YbZn_2$, Yb_3Zn_5, Yb_2Zn_{17}, and $YbZn_{11}$ melt congruently at 650, 751, 752, 754, and 755°C, respectively. The five eutectics are at 491°C and 12 wt % Zn, 645°C and 32 wt % Zn, 687°C and 54 wt % Zn, 742°C and 67 wt % Zn, and 750°C and 77 wt % Zn. The compound Yb_2Zn_{11} undergoes a peritectic decomposition at 695°C. No evidence for the compound $YbZn_{13}$ was observed. Whether this compound is stabilized or inhibited by small amounts of impurities is uncertain. (auth)

36502 SYNTHESIS OF OXIDATION RESISTANT METAL DIBORIDE COMPOSITES. Clougherty, E. V.; Pober, R. L.; Kaufman, L. (ManLabs., Inc., Cambridge, Mass.). Trans. Met. Soc. AIME, 242: 1077-82(June 1968).

Composite structure of hafnium, zirconium, and titanium diboride with additions of metals and/or compound phases was prepared by reactive high-pressure hot pressing and evaluated in air and in mixtures of oxygen and helium at temperatures up to 2400°K and at linear flow rates of 0.1 to 0.2 ft per sec stp. Oxidation characteristics, principally depth of conversion of diboride to dioxide, were determined by a gas analysis method and by post-oxidation metallographic analyses. The best oxidation resistance was observed for hafnium diboride–silicon carbide composite which exhibited a 6-mil conversion to dioxide for a 1-hr oxidation in air at 2200°K compared with a 20-mil recession for hafnium diboride with no additive. Analogous improvements in oxidation resistance were observed for the addition of silicon carbide to zirconium. (auth)

36503 DISLOCATION REACTIONS IN ANISOTROPIC BCC METALS. Hartley, Craig S. (Univ. of Florida, Gainesville). Trans. Met. Soc. AIME, 242: 1101-4(June 1968).

Expressions are obtained for the energy changes associated with the reaction of (a/2) ⟨1 1 1⟩ slip dislocations on intersecting {1 1 0} planes in anisotropic bcc metals. An energy criterion for assessing the likelihood of dissociation of the products of such reactions is also presented. It is found that the barrier reactions which form ⟨1 0 0⟩ dislocations at the intersection of two active {1 1 0} slip planes are more energetically favorable in metals which exhibit a high value of Zener's anisotropy factor, A, than those which have a low value. The results are presented in a form which permits the stacking fault energy to be obtained from a measurement of the separation between partials in a dissociated configuration. However, until accurate calculations or measurements of the stacking fault energies involved are available, it is not possible to assess the physical importance of dissociated dislocations. (auth)

36504 MICROSTRAIN COMPRESSION OF BERYLLIUM AND BERYLLIUM ALLOY SINGLE CRYSTALS PARALLEL TO THE [0001]. PART I. CRYSTAL PREPARATION AND MICROSTRAIN PROPERTIES. London, G. J.; Damiano, V. V.; Conrad, H. (Franklin Inst. Research Labs., Philadelphia). Trans. Met. Soc. AIME, 242: 979-86(June 1968).

A method is described for producing single crystals of high-purity beryllium, Be-4.37% Cu, and Be-5.24% Ni. These crystals

were prepared for testing in compression parallel to the [0001] by orienting and lapping to within ±3′ of arc of the (0001). Microstrain testing apparatus is described along with c axis compression results for ingot purity beryllium, twelve-zone-pass material, and the alloys. Results show no measurable plasticity for the ingot purity material from −196 to 400°C, although some surface traces of $\{1\,1\,\bar{2}\,2\}$ slip was observed at 200°C and above. The twelve-zone-pass material shows substantial microstrain plasticity at 220°C with slip on $\{1\,1\,\bar{2}\,2\}$. Both alloys show significant plasticity at room temperature and above with slip also on $\{1\,1\,\bar{2}\,2\}$ planes. (auth)

36505 MICROSTRAIN COMPRESSION OF BERYLLIUM AND BERYLLIUM ALLOY SINGLE CRYSTALS PARALLEL TO THE [0001]. PART II. SLIP TRACE ANALYSIS AND TRANSMISSION ELECTRON MICROSCOPY. Damiano, V. V.; London, G. J.; Conrad, H. (Franklin Inst, Research Labs., Philadelphia). Trans. Met. Soc. AIME, 242: 987-94(June 1968).

The slip mode activated during the c axis compression of single crystals of commercial-purity ingot SR beryllium, high-purity (twelve-zone-pass) beryllium, and Be-4.4 wt % Cu and Be-5.2 wt % Ni alloys in the temperature range of 25 to 364°C was determined using two-surface slip trace analysis, slip-step height analysis, and electron transmission microscopy. All three techniques indicated the occurrence of copious pyramidal $\{1\,1\,\bar{2}\,2\}\langle 1\,1\,\bar{2}\,3\rangle$ slip in the alloys over the entire temperature range, the amount increasing with temperature. Pyramidal slip was also indicated in the high-purity beryllium by slip trace analysis and electron transmission microscopy, but the amount was somewhat less than in the alloys. For the commercial-purity ingot crystals, only a very small number of pyramidal slip lines were observed and these were in the immediate vicinity of the fracture surface. No pyramidal dislocations could be detected by electron transmission microscopy in this material. Dislocations with Burgers vectors $[0\,0\,0\,1]$ and $\frac{1}{3}\langle 1\,1\,\bar{2}\,0\rangle$ were identified by electron transmission microscopy in the $\{1\,1\,\bar{2}\,2\}$ slip bands, as well as those with the $\frac{1}{3}\langle 1\,1\,\bar{2}\,3\rangle$ vector. This was interpreted to indicate that the edge components of the $\frac{1}{3}\langle 1\,1\,\bar{2}\,3\rangle$ vector dislocations activated during c axis compression dissociate upon unloading according to the reaction $\frac{1}{3}\langle 1\,1\,\bar{2}\,3\rangle \rightarrow [0\,0\,0\,1] + \frac{1}{3}\langle 1\,1\,\bar{2}\,0\rangle$. (auth)

36506 RATE THEORY OF DISLOCATION MOBILITY. Krausz, A. S. (National Research Council of Canada, Ottawa). Acta Met., 16: 897-902(July 1968).

The direct and indirect methods of dislocation velocity (v) measurements usually lead to the empirical expression $v \propto \tau^n$ or $v \propto \exp(-c/\tau)$ where τ is the stress and n, c are experimental constants. It is shown that the dislocation velocity can be described in terms of physical concepts by using the rate theory model of the asymmetrical energy barrier and assuming that the activation energy of the rate controlling process is linearly dependent on the stress. The equation obtained describes well the dislocation velocity in LiF, Ge, Si, InSb, GaSb, NaCl, Fe–Si, Ni, W, Zr, Pb, and in ice. An interpretation of the stress exponent n was also obtained in terms of the size and the shape of the energy barrier. This expression can be directly related to the yield drop and delay time phenomena. (auth)

36507 TEXTURES IN DEFORMED ZIRCONIUM SINGLE CRYSTALS. Hobson, D. O. (Oak Ridge National Lab., Tenn.). Trans. Met. Soc. AIME, 242: 1105-10(June 1968).

Zirconium single crystals of various specific orientations were fabricated by rolling or drawing. The resulting textures were determined and are discussed with respect to the deformation modes that produced them. The crystals deformed in a predictable manner by combinations of up to third-order twinning with three twinning modes and by slip. Twinning was found to play a major role in initial texture formation. Texture changes produced by slip occurred only at the higher reductions. The twinning sequences that produced each intensity peak during the initial reductions could be identified. Schmid factor criteria were found useful in predicting which deformation modes to expect for each crystal orientation and fabrication procedure. The possible application of these data to polycrystalline material is discussed. (auth)

Radiation Effects

Refer also to abstracts 35879, 36011, 36449, 36546, 37541, and 37566.

36508 (AD-661229) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, May 1–July, 31, 1967. Hawthorne, J. Russell; Serpan, Charles Z. Jr.; Watson, Henry E.; Loss, Frank J.; Potapovs, Uldis (Naval Research Lab., Washington, D. C.). Aug. 15, 1967. 47p. (NRL-MR-1808). CFSTI.

Reports on through-thickness radiation resistance of two A533 Grade B, Class I steel plates at 550°F, directional notch ductility performance of irradiated 3½ Ni–Cr–Mo and 5 Ni–Cr–Mo–V steel plates, radiation sensitivity of A353 (9% nickel) steel as influenced by percent retained austenite, tensile properties behavior versus postirradiation test temperature of selected structural steels, potential for aging embrittlement of pressure vessel steels, postpressurization test operations on PM-2A reactor pressure vessel, and auxiliary equipment developed for elevated temperature remote tension testing of radioactive specimens are presented. (auth)

36509 (CONF-671005-7) IRRADIATION PERFORMANCE OF URANIUM–PLUTONIUM CARBIDE FUELS: THE USA EXPERIENCE. Strasser, A. A. (United Nuclear Corp., Elmsford, N. Y.); Kittel, J. H. (Argonne National Lab., Ill.). [1967]. 34p. Dep. CFSTI.

From Nuclear Metallurgy Conference, Phoenix, Ariz.

The United States irradiation experience with uranium-plutonium carbides is presented, and their performance potential is evaluated. Uranium-plutonium carbides have been irradiated in the form of high-density pellets to 114,000 MWd/t, low-density pellets to 18,000 MWd/t, and vibratory compacted particles to 62,000 MWd/t at powers up to 330 W/g, 260 W/g, and 470 W/g, respectively, in thermal and fast reactors. All rods were helium bonded. The fuel performed without significant microstructural changes, such as melting or grain growth. Plutonium redistribution or fission product segregation did not occur. Voids due to fission gas agglomeration formed at the center of high-density pellets above 250 W/g or above 100,000 MWd/t. The maximum clad OD increase was 0.9% per 10,000 MWd/t. One percent of the fission gases were released from high-density pellets below 16×10^{20} fissions/cc, and 40% above 32×10^{20} fissions/cc. All clads were intact below ~30,000 MWd/t. Above this level, brittle fractures of stainless steel clads occurred–although all refractory clads were intact. The thermodynamic compatibility of the carbides with stainless steel, niobium, and vanadium clads was excellent up to 10,600 hr of operation. Six full-length fuel rods containing solid-solution pellets, vibratorily compacted mixed particles, and vibratorily compacted solid-solution particles were recently removed from EBR-II after irradiation up to 28,000 MWd/t. The elements have been irradiated at a maximum linear heat rating of 950 W/cm (29 kW/ft) in type 316 stainless steel, vanadium, and vanadium-20 wt % titanium cladding. Examination of the fuel rods indicated that the cladding of all three elements was intact except for a weld crack in the V-20 wt % Ti. Measurements show that less than 0.5% of the fission gas was released by the high-density pellets, and less than 20% from the vibratory compacted particles. Preliminary metallographic examinations indicated no melting or grain growth in the high-density pellets. Small fission gas voids form in the center of the rods at the higher powers. Sintering of vibratory compacted material occurred in solid solution material at 950 W/cm (29 kW/ft), but not in physically mixed particles at 820 W/cm. (auth)

36510 (EURAEC-2037) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Quarterly Report No. 9, October 1–December 31, 1967. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). May 1968. Contract 074-65-10-TEEI(RD). 9p. (EUR-3987). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Work done under the research contract 074-65-10 TEEI (RD) in the Istituto Elettrotecnico Galileo Ferraris during the quarter October 1–December 31, 1967, is reported. Information is included on radiation damage recovery studies by annealing treatments under magnetic fields, interactions of C and N with defects introduced by neutron irradiation, and on magnetic properties of Permalloy irradiated in different positions with reference to the reactor core. (auth)

36511 (N-68-16876) EFFECTS OF NEUTRON RADIATION ON STRUCTURAL MATERIALS. Kangilaski, M. (Battelle Memorial Inst., Columbus, Ohio. Radiation Effects Information Center). June 30, 1967. Contract NASw-1568. 245p. (NASA-CR-93128; REIC-45). CFSTI.

A compilation of the data available on the effects of radiation on tensile, creep, fatigue, impact, and hardness properties of various structural materials is presented. These properties are given as a function of test temperature, irradiation temperature, and radiation fluence. Specifically the following reactor materials are covered: (1) aluminum alloys, (2) magnesium alloys, (3) beryllium, (4) zirconium alloys, (5) mild steels, (6) stainless steels, (7) nickel alloys, and (8) refractory metals. Data on the effects of radiation on the mechanical properties of selected materials at cryogenic temperatures also are included. (auth) (STAR)

36512 (WAPD-TM-756) ESTIMATED CREEP PROPERTIES OF ZIRCALOY DURING NEUTRON IRRADIATION (LWBR DEVELOPMENT PROGRAM). Nichols, F. A. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1968. Contract AT(11-1)-Gen-14. 33p. Dep. CFSTI.

A comprehensive model is proposed to explain the creep of Zircaloy during neutron irradiation. The in-pile softening observed at low stresses is hypothesized to be due to the growth-directed Roberts–Cottrell yielding creep originally proposed for α-uranium, or the formation of point defect loops preferentially on certain planes in response to the applied stress, (which may or may not be followed by yielding creep), or to a combination of these two mechanisms. The in-pile hardening observed at high stresses (or strain-rates) is proposed to be due to the cutting by dislocations of depleted zones as originally proposed to account for post-irradiation hardening. In this stress (strain-rate) region, in-pile behavior is identical to post-irradiation behavior. At intermediate stresses (strain-rates) a mechanism of radiation-enhanced climb around depleted zones is suggested as being rate-controlling. As the stress is decreased, the climb process becomes easier and the rate is then controlled by glide at a flow stress characteristic of unirradiated, annealed material, it being proposed that radiation-enhanced diffusion enables climbing around the normal strain-hardening obstacles. At still lower stresses, this glide process becomes negligibly slow compared with the growth connected creep mechanism which is presumed to operate independently. The overall scheme is shown to be in good agreement with all the in-pile data presently available. (auth)

36513 CHARGED-PARTICLE TRACKS IN SOLIDS. Goland, Allen N. (Brookhaven National Lab., Upton, N. Y.). pp 159-335 of Studies in Radiation Effects. Vol. I. Dienes, G. J. (ed.). New York, Gordon and Breach Sciences Publishers, Inc., 1966.

Investigations of charged-particle tracks in solids are reviewed. Theoretical aspects are discussed. It was concluded that the behavior of "hot" electrons within individual crystallites comprising thin films is the controlling factor in the production of evaporation tracks. Nuclear fission, stopping power of solids, radiation-damage models related to track formation, electron microscopy, experimental results, mineral dating by determination of fission-track ages, and solid-state detectors are discussed. (M.C.G.)

36514 RADIATION EFFECTS IN BERYLLIUM AND BERYLLIUM OXIDE. Hickman, B. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). pp 72-158 of Studies in Radiation Effects. Vol. I. Dienes, G. J. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1966.

Available information on the mechanisms of radiation damage in Be and BeO is reviewed, the effect of this damage on the macroscopic properties is outlined, and the consequences of these property changes on the utilization of the materials are discussed. Topics covered include: damage due to atomic displacements, nucleation and growth of helium bubbles, swelling, changes in mechanical properties, studies of defect structure, the behavior of helium and tritium, and utilization. (M.C.G.)

36515 SELF-IRRADIATION OF PLUTONIUM AND ITS ALLOYS. Elliott, R. O.; Olsen, C. E. (Los Alamos Scientific Lab., N. Mex.). pp 1-71 of Studies in Radiation Effects. Vol. I. Dienes, G. J. (ed.). New York, Gordon and Breach Scientific Publishers, Inc., 1966.

Studies on the self-irradiation of plutonium and its alloys to both moderate and high damage levels are reported. Measurements were made on electric resistivity, thermoelectric power, specific heat, and preferred orientation. Theoretical calculations, saturation of damage, interband scattering, and antiferromagnetism are discussed. (M.C.G.)

36516 STUDIES IN RADIATION EFFECTS. SERIES A. PHYSICAL AND CHEMICAL. VOLUME 1. Dienes, G. J. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1966. 452p. $19.50 Hardbound; $12.50 Professional.

Radiation effects on solids are considered under the following topics: self-irradiation of plutonium and its alloys, radiation effects in beryllium and beryllium oxide, and charged-particle tracks in solids. Separate abstracts were prepared for the three papers. (M.C.G.)

For abstracts of individual papers see: 36513–36515.

36517 MODULUS EFFECTS IN METALS AFTER LOW TEMPERATURE ELECTRON IRRADIATION. III. ALUMINUM. Keefer, D. W. (Atomics International, Canoga Park, Calif.); Robinson, J. C.; Sosin, A. Acta Met., 16: 927-37 (July 1968).

A study of electron irradiated aluminum was made by means of modulus measurements. Damage production data have been obtained at ≤ 10°K and compared with similar data from Cu and Au. Detailed isochronal annealing studies have been made between about 10 and 500°K following irradiation, quenching, and quenching plus irradiation. Two pinning stages have been observed following irradiation, one between about 20 and 50°K (Stage I) and the other between about 240 and 360°K (Stage IV). The two pinning stages are separated by a temperature interval in which a general reduction in modulus occurs. The isochronal data are compared with similar results obtained on Cu and Au and are correlated with yield stress and resistivity results obtained on Al. (auth)

36518 PRECIPITATION IN NEUTRON-IRRADIATED Al-BASE CU. Katz, L. E. (Univ. of Pennsylvania, Philadelphia. Brookhaven National Lab., Upton, N. Y.); Herman, H.; Damask, A. C. Acta Met., 16: 939-45 (July 1968).

A detailed study was carried out on the effects of irradiation (at 40°C) with reactor neutrons on the kinetics of formation of θ' in Al–1% Cu at 110 and 130°C. The observed increased rate of precipitation is attributed to enhanced nucleation at damage centers. There is evidence that the acceleration effect saturates at doses of the order of 10^{18} nvt (fast) for aging at 130°C. No enhancement of precipitation at 235°C is observed after irradiation of heat-treated 1, 2 and 4% alloys. This negative result is found for doses from about 10^{14} to 10^{17} nvt (fast). It is concluded that the damage centers are dissolved at this high aging temperature. High-dose experiments [of the order of 10^{19} nvt (fast)] show clear acceleration of the formation of θ' in the Al–4% Cu. Enhanced nucleation results from the bombardment, but the precipitate particles which form in the irradiated alloy are structurally indistinguishable from those which occur in the unirradiated alloy. (auth)

36519 ELEVATED TEMPERATURE IRRADIATION HARDENING IN AUSTENITIC STAINLESS STEEL. Holmes, J. J.; Robbins, R. E.; Brimhall, J. L.; Mastel, B. (Battelle Memorial Inst., Richland, Wash.). Acta Met., 16: 955-67 (July 1968).

The nature and magnitude of radiation hardening in an 18-8 type austenitic stainless steel were investigated after a high neutron exposure (1.4×10^{22} n/cm^2, E > 0.18 MeV) near one-half the absolute melting temperature (532°C). Transmission electron microscopy was used to reveal substructural features prior to tensile testing over the temperature range 23 to 871°C. The irradiation produced a substructure consisting of Frank sessile loops about 400 Å in diameter and 3.7×10^{15}/cm^3 in density and polyhedral cavities approximately 150 Å in diameter and about 2×10^{14}/cm^3 in density. Annealing for one hour at 593°C induced the Frank sessile loops to transform into perfect dislocation loops which, in turn, migrated and interacted to form a complex dislocation network. Annealing at progressively higher temperatures resulted in simultaneous cavity and network annihilation at 816°C. After irradiation, the yield strength follows a thermally activated temperature dependency at test temperatures less than $T_m/2$. The athermal yield stress component is attributed to the strengthening expected from the Frank sessile loops. Above $T_m/2$, the loops are annihilated and a corresponding decrease in yield strength occurs. However the strength does not approach the unirradiated control value as the loop density tends to zero but remains at a value which is consistent with the experimentally determined density of cavities. Full recovery of the yield strength is observed at 816°C when both the dislocations and cavities are annihilated. (auth)

36520 MEASUREMENT OF FAST RESISTIVITY CHANGES OF METALS DURING AND AFTER IRRADIATION BY REACTOR PULSES. Eskelson, N.; Weiss, H. (Atominstitut der Oesterreichische Hochschule, Vienna). Atomkernenergie, 13: 193-8 (May-June 1968). (In German).

The possibilities for the measurement of fast resistivity changes of metals during and after pulse irradiations in the TRIGA Mark II reactor are investigated. By means of a bridge circuit the changes of the resistivity are transformed into changes of a voltage to be amplified and recorded. With the apparatus described relative resistivity changes of 0.2 percent can be measured with an accuracy of 0.1 percent, if the power consumption of the sample is allowed to reach 1 watt. This means that resistivity changes of 2×10^{-4} percent are just detectable. For samples with resistivities below 1 Ohm the accuracy will be limited by the noise of about 1 μV effective at the input of the measuring amplifier. All data apply to resistivity changes of the sample which correspond to a band width of 0 to 100 cps. With digital registration techniques up to 1000 readings per second can be obtained. The problems arising from heating the sample by irradiation are discussed. Furthermore, results of measurements are given for several metals and methods for further decreasing the temperature effect are suggested. The apparatus described may be used also for the measurement of fast resistivity changes of metals as they arise in some research work in metallurgy. (auth)

Ceramics and Cermets

Corrosion and Erosion

36521 COMPATIBILITY OF ALUMINA AND BERYLLIA CERAMICS WITH POTASSIUM VAPOR. McRae, R. C.; Reed, L.; Toth, J.; Lindberg, R. (EIMAC, San Carlos, Calif.). Amer. Ceram. Soc. Bull., 47: 484-7(May 1968).

The use of liquid metals such as Li, Na, or K and their vapors in the primary and secondary heat transfer loops of nuclear power units to drive turbines, presently under development for space applications, presents a problem in shielding stationary alternator windings from the corrosive alkali metal vapors. One solution consists in providing a vapor shield around the stator windings. Design information for the construction of such vapor shields, or bore seals, is presented. High alumina and beryllia ceramics were exposed to K vapor at pressures to 2 atm and at temperatures to 870°C. The ceramics, in the form of modulus of rupture bars, were exposed for 500 hr in Nb–1Zr alloy capsules loaded under controlled conditions which resulted in sealed capsule K contamination levels of 26 ppM oxygen or less. Compatibility was defined as the ratio of the strength of K-exposed ceramics to the strength of identical ceramic specimens exposed at the same time and at the same temperature to vacuum. Potassium attack takes place via the grain boundaries of the ceramics, largely due to the presence of silica. A logarithmic plot of silica content vs structural compatibility index, as defined, indicated that silica levels must be kept well below 500 ppM for long-term usefulness at 870°C. (BBB)

Preparation and Fabrication

36522 (BAW–3714–6) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 6, November 1967–January 1968. Gurley, R. N. (comp.) (Babcock and Wilcox Co., Lynchburg, Va.). May 1968. Contract AT(30-1)-3714. 52p. Dep. CFSTI.

Development of the Gel-Addition process for preparing mixed plutonia-urania fuels has continued. In addition, the overall program was extended to include the development of a pilot plant for the industrial production of $(U,Pu)O_2$ particulate fuel using the ORNL mixed-sol approach. This task also includes sol and gel preparation studies. Emphasis was placed on a statistically controlled plutonium addition experiment, improving analytical methods, irradiation testing of a calibration capsule (UO_2–20 wt % PuO_2 fuel), and single and mixed sol studies. Notable success was achieved in each of these areas. Plutonium pickup mechanisms were hypothesized. Controlled-potential coulometric analysis of Pu(VI) in plutonium solutions was developed and adopted for regular laboratory use. The fabrication of capsules for use in inpile restructuring studies was started, since the results of a calibration capsule experiment confirmed the validity of the associated nuclear and thermal design parameters. Uranium dioxide sols and spheres can now be produced routinely using laboratory and pilot plant equipment. (auth)

36523 (BMI–1840) FABRICATION OF FULLY DENSE (U,Ta)C ALLOYS BY POWDER-METALLURGY TECHNIQUES. Lowder, James T.; Speidel, Edward O.; Kizer, Donald E. (Battelle Memorial Inst., Columbus, Ohio). June 11, 1968. Contract W-7405-eng-92. 42p. Dep. CFSTI.

Powder-metallurgy techniques were studied to fabricate homogeneous (U,Ta)C alloys of near theoretical density. The procedure developed involved: comminution of UC and TaC to powders with a particle size of less than 10 μ, consolidation of UC and TaC powder mixtures by unidirectional vacuum hot pressing, homogenization of the UC-TaC compacts, comminution of the (U,Ta)C alloy to powder with an average particle size of 20 μ, and consolidation of the (U,Ta)C powder to near theoretical density by unidirectional vacuum hot pressing. Densities greater than 99% of theoretical were obtained by vacuum hot pressing $(U_{0.7}Ta_{0.3})C$ and $(U_{0.5}Ta_{0.5})C$ powders for 15 min at 1800°C and 10,000 psi (703 kg per cm^2) and $(U_{0.3}Ta_{0.7})C$ powders for 15 min at 2000°C and 10,000 psi. The hot hardness of as-hot-pressed $(U_{0.7}Ta_{0.3})C$, $(U_{0.5}Ta_{0.5})C$, and $(U_{0.3}Ta_{0.7})C$ decreased rapidly above 1400°C. The hot hardness of $(U_{0.3}Ta_{0.7})C$ annealed at 2400°C exhibited no sharp decrease at temperatures to 1700°C. Long-term heat treatments (up to 250 hr) were conducted. The $(U_{0.7}Ta_{0.3})C$ and $(U_{0.5}Ta_{0.5})C$ alloys exhibited a thermal instability below 1800°C. The $(U_{0.3}Ta_{0.7})C$ alloy appeared thermally stable within the times investigated to temperatures of 2100°C. (auth)

36524 (BMI–1842) PREPARATION AND PROPERTIES OF UO_2, UN, AND UC CERMET FUELS. Speidel, Edward O.; Kizer, Donald E.; Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). June 11, 1968. Contract W-7405-eng-92. 70p. Dep. CFSTI.

Hot isostatic pressing was used as the technique for preparing cermets containing at least 50 vol % UO_2, UN, or UC and having minimum densities of 90% of theoretical. Tungsten, molybdenum, chromium, and niobium were employed as matrix materials. Spherical UO_2 and UC and angular UC and UN powders were evaluated. Hot isostatic pressing produced specimens with a uniform structure and was demonstrated to be capable of simultaneously densifying and cladding green-pressed or vibratory-compacted cermet fuels. Roll blending was the most successful technique in producing a homogeneous mixture of powders with both irregular- and spherical-shaped fuel particles. Powder-blended microstructures appeared similar to those obtained by using UO_2 particles coated with tungsten and molybdenum by vapor-deposition techniques. So far as direct comparison is possible, the cermets were superior in bend and compressive strengths to the bulk ceramics. Compression tests were conducted at room temperature and 1000°C to evaluate the effect of temperature on strength. Reductions in length of 1.2 to 2.1% were measured on the cermets at 1000°C at their maximum compressive load. The loading, density, and uniformity of structures appeared to affect strength. The thermal conductivity of UO_2 cermets was up to 14 times greater than that reported for bulk UO_2. The conductivities of UN and UC cermets were slightly higher or equal to those of bulk UN and UC, respectively. Thermal-expansion data indicated that the cermet fuels matched potential cladding materials better than the pure ceramic fuels. Electrical-resistivity data confirmed the metallic nature of the cermets. (auth)

36525 (LA-DC–9602) ELECTRO-MECHANICAL POLISHING OF SOME REFRACTORY CARBIDES CONTAINING GRAPHITE. Jones, T. I. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 12p. (CONF-680614–1). Dep. CFSTI.

From 22nd AEC Metallography Group Meeting, San Diego, Calif.

Refractory carbides with associated graphite phases were polished using the electro-mechanical polishing technique. This method yields a surface with less flowed material than does standard mechanical polishing methods. The procedure was adapted for polishing graphite and predominately graphic matrices for optical microscopic examination. (auth)

36526 (LA-DC–9616) THE METALLOGRAPHIC PREPARATION AND MICROSCOPIC EXAMINATION OF A MOLYBDENUM–URANIUM-DIOXIDE CERMET FUEL. Schuyler, D. R.; Gregory, T. G. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 22p. (CONF-680614–2). Dep. CFSTI.

From 22nd AEC Metallography Group Meeting, San Diego, Calif.

A procedure for the metallographic preparation of tungsten-coated Mo–UO_2 cermet fuels was developed specifically for their subsequent examination by replica electron microscopy. Both polishing and etching procedures were evaluated as well as replication techniques for electron microscopy. The best polishing techniques involved the use of an alumina–chromic acid slurry on rotating cloth laps. Etching of the UO_2, as well as other portions of the material, could be accomplished with a variety of etchants that would affect only specific structures. Examination of the prepared surface by replica electron microscopy could reveal fission product voids down to 100 Å in diameter. (auth)

36527 (UCRL–18191) IMPURITY EFFECTS IN SINTERING LEAD ZIRCONATE TITANATE. Pryor, Gary Alan (California Univ., Berkeley. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 46p. Dep. CFSTI.

Thesis.

Investigations into the effects of ball milling impurities on the sintering of lead zirconate titanate (PZT) were conducted. Varying amounts of Al_2O_3 and SiO_2 were added to a high purity, fine particle size powder obtained from special processing. Alumina additives were found to increase sintering by forming a liquid aluminate phase which wet the PZT grains and inhibited grain growth. Silica additives had a smaller effect on sintering than alumina. The formation of a siliceous liquid which did not wet the PZT grains and did not inhibit grain growth was observed. The optical microscope, electron microprobe, and scanning electron microscope were used in the above analysis. A minor effect of atmosphere on sintering was observed indicating that gas entrapment in closed pores during sintering may occur and leads to lower densities. It is concluded that liquid phases make a major contribution to the sintering of lead zirconate titanate. (auth)

36528 BOROTHERMIC PREPARATION OF SOME VANADIUM, NIOBIUM, AND TANTALUM BORIDES. Peshev, P.; Leyarovska, L.; Bliznakov, G. (Bulgarian Academy of Sciences, Sofia). J. Less-Common Metals, 15: 259-67(July 1968).

The formation of V, Nb and Ta diborides by the reactions of V_2O_3, Nb_2O_5 and Ta_2O_5 with elemental B under vacuum in the temperature range 1000 to 1750°C has been investigated. It has been established that Nb and Ta diborides with a composition close to that of stoichiometric NbB_2 and TaB_2 are obtained after a heat treatment of the reactants at 1650°C for 1 hr. Borothermic reduction of V_2O_3 does not give a single-phase product but a mixture of VB_2 and VB. A method for the chemical analysis of NbB_2- and TaB_2 samples has been proposed. (auth)

36529 PREPARATION OF HIGH QUALITY URANIUM CARBIDE. Hanson, Lloyd A. (to United States Atomic Energy Commission). U. S. Patent 3,392,005. July 9, 1968.

A process for preparing high-density, low-oxygen content uranium carbide by using a nickel additive during carbothermic reduction of uranium oxide to uranium carbide is described. (AEC)

36530 PROCESS FOR THE FUSION OF METAL OXIDES. Hoppe, W.; Mueller, N.; in der Schmitten, Wilhelm (to United States Atomic Energy Commission). U. S. Patent 3,387,079. June 4, 1968.

Metal oxide compacts are fused in a furnace where they have been placed in the form of a column. The column of compacts is preheated to establish electrical conduction between the compacts. After preheating, the compacts are surrounded by a powder of the metal oxide and an alternating current is passed through the compacts to fuse them together. (auth)

36531 PROCESS FOR MAINTAINING STRAIGHTNESS IN EXTRUDED CERAMIC SECTIONS. Zambernard, M. J. (to United States Atomic Energy Commission). U. S. Patent 3,393,256. July 16, 1968.

A process for drying of extruded rod-like UO_2 sections prior to sintering to reduce warping and out of roundness in the final product is described. The sections are mounted in a rotatable drum by way of oversized openings in the supporting end plates to permit the sections to roll within the holes as the drum is rotated. (AEC)

36532 METHOD FOR PRODUCING SINTERED CERAMIC NUCLEAR FUEL WITH BORIDE ADDITIONS. Watanabe, Takaaki (to Mitsubishi Atomic Power Industries, Inc.). Japanese Patent 1967-15506. Aug. 26, 1967. Filed Mar. 19, 1964.

A method to produce fuels with uniform boron-distribution; high density fuel without residual C, N, and O; and properties associated with high precision in fabrication is proposed. The process consists of two continuous sintering stages. To a mixture of UO_2 and ZrB_2, TiB_2 or MoB_2 powders are added an organic molding-agent of the hydrocarbon system and a solvent and molded into a given shape. The mold is heated in a sintering furnace in a reducing atmosphere at a temperature near the boiling point of the molding agent. The mold is cooled and again heated in vacuum to a specific temperature for the purpose of sintering. (NSA of Japan)

36533 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Davies, Jared Marshall; McLean-Elrick, Alexander (to United Kingdom Atomic Energy Authority). British Patent 1,113,425. May 15, 1968. Filed Sept. 17, 1964.

A reactor fuel assembly, capable of operating up to 1000°C, comprises a UC fuel in a stainless steel can and interlayers of a barrier material, as Nb, Ta, or W to prevent diffusion of UC in the can. (P.G.C.)

Properties Evaluations

Refer also to abstracts 35825, 35826, and 36524.

36534 (BNWL-724) SCIENTIFIC EXCHANGE ASSIGNMENT TO JAPAN. A Review and Evaluation. Daniel, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 56p. Dep. CFSTI.

A scientific exchange assignment to Japan is evaluated and reviewed. The participant directed a new research program on high stress deformation and bonding mechanisms of UO_2. He participated in Japanese company, government laboratory, and professional activities, presented talks and papers, and attended international conferences. Personal life arrangements for living in Japan are detailed. (J.C.W.)

36535 (LA-3938) POROSIMETRY DATA INTERPRETATION. Dickinson, J. M.; Lewis, H. D. (Los Alamos Scientific Lab., N. Mex.). Jan. 1968. Contract W-7405-eng-36. 13p. Dep. CFSTI.

Statistical models developed for particle size analysis were used for the interpretation of porosimetry data. A brief outline of the development of the finite interval and the log normal models is given, with emphasis on assumptions and conditions required for applicability to porosimetry data. Methods of calculations based on both models are illustrated. (auth)

36536 (SC-DR-68-295) SAMARIA-TUNGSTEN CERMET IMPACT TESTS. Hill, B. S. (Sandia Corp., Albuquerque, N. Mex.). June 1968. 38p. Dep. CFSTI.

Two samaria-tungsten cermets were impact tested on granite at 200 and 250 fps. The cermets comprised SmO_2 microspheres coated by chemical vapor deposition with 20 vol % W and encapsulated in W-25 Re clad. Dummy capsules containing hot-pressed Sm_2O_3 were also tested. Metallographic analysis and visual observation showed only slight cracking of the capsule and no gross failure of the cermet. (D.L.C.)

36537 SELF-DIFFUSION OF OXYGEN IN Y_2O_3 AND Er_2O_3. Wirkus, C. D.; Berard, M. F.; Wilder, D. R. (Ames Lab., Iowa). Contract W-7405-eng-42. J. Amer. Ceram. Soc., 50: 113 (Feb. 21, 1967). (IS-1444).

A technique was developed for determining the rate of self-diffusion of oxygen in rare earth sesquioxides based on the use of slightly reduced rare earth oxides that oxidize to stoichiometry on heating in air. The rate of weight gain can be determined by a thermobalance and the diffusion coefficients calculated. A least squares fit of the data to the Arrhenius equation given: for Y_2O_3 (1000 to 1500°C), $D = 7.24 \exp(-58{,}600/RT)$, and for Er_2O_3 (850 to 1250°C), $D = 1.22 \exp(-47{,}800/RT)$. (M.C.G.)

36538 LATTICE PARAMETERS OF GRAPHITE IN RELATION TO FRICTION AND WEAR. Arnell, R. D.; Teer, D. G. (English Electric Co., Whetstone, Eng.). Nature (London), 218: 1155-6(June 22, 1968).

Under vacua <1 torr the coefficient of friction of graphite on itself and other materials increases very substantially and the wear rate becomes very high. It has also been shown that small partial pressures of condensable vapors (for example, 3 torr of water vapor) can restore the coefficient of friction and the wear rate to low values, and it is concluded that the normal low friction behavior of graphite is a result of the presence of condensable vapors. Two mechanisms have been suggested whereby vapors can lower the coefficient of friction. The first is that the surfaces of graphite crystals are covered by monolayers of condensable vapors which saturate the surface forces and give a surface analogous to a boundary lubricating oil film. The second mechanism involves penetration of the crystal lattice by the vapors, reducing the interlayer binding energy and allowing easy shear of the lattice parallel to the basal plane. Evidence against the second mechanism is presented. The lattice parameters of polycrystalline natural graphite were measured under the following conditions: (a) material outgassed at 1000°C and 5×10^{-6} torr for periods of one week, then sealing under vacuum and at temperature; (b) outgassed as in (a) and then reopened to ambient atmosphere. Results are tabulated, and there were no significant differences between the two sets of measurements. It is therefore suggested that there was no significant expansion of the crystal lattice as a whole resulting from intercalation of condensable vapors. The results do not preclude the possibility that vapors on the surface would weaken the interlayer bonding of the first few atomic layers, but they do indicate that changes in bulk mechanical properties with out-gassing cannot be a result of the removal of intercalated vapors. (UK)

36539 PHYSICAL AND MECHANICAL PROPERTIES OF REFRACTORY COMPOUNDS. Steinitz, Robert (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). pp 155-83 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

Refractory compounds discussed are the transition-metal carbides, borides, and nitrides. The properties discussed are important to the nuclear structural material applications. Melting points, electrical properties, magnetic properties, mechanical properties, plastic properties, electronic structure, and the diffusion rates of metal and carbon are discussed. (J.C.W.)

36540 DESIGN WITH BRITTLE MATERIALS: PRESENT AND FUTURE. Anthony, Frank M. (Bell Aerosystems Co., Buffalo). pp 269-304 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

Considerations for the design of efficient ceramic components are discussed. Design aspects include selection of proper material, ability to produce the desired configuration, maintenance of similarity, maximization of performance reproducibility, and generation of test data. (J.C.W.)

36541 THERMODYNAMICS OF REFRACTORY MATERIALS. Storms, Edmund (Los Alamos Scientific Lab., N. Mex.). pp 67-131 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

The heat of formation of refractory materials changes with composition. The change has been defined in the VC, NbC, TaC, and HfC systems. Data on these systems are presented graphically. The information for the ZrC and UC systems is limited. High temperature enthalpy and heat capacity of Nb, Ta, Mo, TiC, ZrC, TaC, NbC, Nb–C, and HfC are summarized in graphs. The high temperature heat capacity of UC and $UC_{1.8}$ is presented. Data on the solubility of oxygen in refractory compounds are summarized in the reactions associated with heating the Ti–C and Zr–C alloys. The dissolution of oxygen in carbides affects the thermodynamic properties. Vapor pressure data and measurements of TiC, ZrC, HfC, NbC, TaC, MoC, ThC_2, and UC are summarized. The thermal functions of the carbides and uranium are tabulated. (J.C.W.)

36542 DISPERSED-PARTICLE DEFORMATION IN WC–Co ALLOYS. Smith, J. T.; Wood, J. D. (Lehigh Univ., Bethlehem, Pa.). Trans. Met. Soc. AIME, 242: 1181-2(June 1968).

The alloy system WC-12 wt % Co consisted of noncoherent WC particles dispersed in the cobalt matrix. Some particle-to-particle contact existed. The microstructure of the WC particles was characterized by very straight edges, forming a trapezoidal shape in any plane of polish. A series of experiments was performed to evaluate the influence of loading rate on the deformation of the alloy. The average particle size was 4.45 μ with an average linear separation between particles of 0.59 μ, and at a selected temperature of 800°C. Results suggest that the rate of application of load greatly influences the plastic deformation of two-phase alloys. (J.C.W.)

Structure and Phase Studies

Refer also to abstract 37043.

36543 (ANL–7450, pp 39-74) MATERIALS CHEMISTRY AND THERMODYNAMICS. (Argonne National Lab., Ill.).

Research progress is reported on high-temperature materials development, chemistry of irradiated fast reactor fuels, preparation of reactor materials and ceramic fuels, calorimetry, and chemistry of liquid metals. (M.C.G.)

36544 EFFECT OF OXIDE ADDITIONS ON THE POLYMORPHISM OF TANTALUM PENTOXIDE (SYSTEM Ta_2O_5–TiO_2). Waring, J. L.; Roth, R. S. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 72A: 175-86(Mar.-Apr. 1968).

The phase equilibrium relationships of the $TiO_2 \cdot Ta_2O_5$ system were determined in air. An equimolar compound, $TiTa_2O_7$, was found to melt congruently at about 1662°C and have a monoclinic unit cell a = 20.297 Å, b = 3.804 Å, c = 11.831 Å, β = 120°14′, apparently isostructural with $TiNb_2O_7$. In addition, two other compounds are postulated to occur at about TiO_2: $49Ta_2O_5$ and TiO_2: $7Ta_2O_5$ and to dissociate at about 1230 and 1190°C, respectively. TiO_2 apparently accepts a maximum of 9 mole percent Ta_2O_5 in solid solution at 1630°C. Two eutectics occur in the system at 54 mole percent Ta_2O_5 and 1650°C and 31 mole percent Ta_2O_5 and 1630°C. The high temperature form of Ta_2O_5 is apparently triclinic at room temperature with a = 3.801 Å, b = 3.785 Å, c = 35.74 Å, α = 90°54.4′, β = 90°11.5′, and γ = 89°59.9′. A metastable transition occurs at 320°C to a monoclinic form which inverts to tetragonal at 920°C with a = 3.81 Å, c = 36.09 Å. Several intermediate morphotropic phases are found with up to 9 mole percent TiO_2 in solid solution. (auth)

36545 SOME NEW BORON-RICH PHASES IN THE SYSTEM BORON–THORIUM. Etourneau, Jean; Naslain, Roger (Faculte des Sciences, Bordeaux). Compt. Rend., Ser. C, 266: 1452-5 (May 6, 1968). (In French).

The action of thorium on boron between 800 and 2200°C for atomic ratios of B/Th ≥ 4 made it possible to obtain, in addition to ThB_4 and ThB_6, two new phases γ and δ. The γ phase, which corresponds essentially to the formula ThB_{18}, is formed by the action of boron on ThB_6 between 1300 and 1600°C. The δ phase, obtained at 1900°C for very high ratios of B/Th, with cubic symmetry (a = 23.46 ± 0.01 Å), and with space group Fm3c (O_h^5), appears to possess the structure of YB_{66}. The regions of thermal stability of these various phases are defined. (tr-auth)

36546 STUDY OF THE ZIRCONIUM OXIDE–PRASEODYMIUM OXIDE AND ZIRCONIUM OXIDE–TERBIUM OXIDE SYSTEMS AT HIGH TEMPERATURE. Rouanet, Alain (CNRS, Montlouis, France). Compt. Rend., Ser. C, 266: 1230-3(Apr. 17, 1968). (In French).

Samples of zirconium oxide–praseodymium oxide and zirconium oxide–terbium oxide were prepared. The products were fused and tempered in air, and some were then annealed in air at 800°C. The deviations from stoichiometry of the oxides of Pr and Tb with respect to the sesquioxides were determined, and the results are graphed. The parameters of the face-centered cubic cell of ZrO_2–Pr_2O_3 and of the cubic cell of ZrO_2–Tb_2O_3 are shown graphically. (J.S.R.)

36547 VARIOUS FORMS OF CARBON. Nightingale, R. E. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. pp 203-28 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

The structure of the perfect graphite crystal is discussed. A wide variety of properties can result from deviations from this structure. The preparation and properties of natural graphite, electrographite, carbon black, and pyrolic carbon are discussed in detail. (J.C.W.)

36548 PHASE DIAGRAMS OF SELECTED REFRACTORY COMPOUNDS. Farr, John D. (Los Alamos Scientific Lab., N. Mex.). pp 33-48 of Fundamentals of Refractory Compounds. Hausner, Henry H.; Bowman, Melvin G. (eds.). New York, Plenum Press, 1968.

Phase diagrams of the systems Ti–C, Ta–C, W–C, Zr–B, Nb–B, Mo–B, Zr–ZrN, Mo–Si, Th–P, U–C, Zr–W–B, and Zr–Si–C are given. (J.C.W.)

36549 LEED FROM SURFACE STEPS ON UO_2 SINGLE CRYSTALS. Ellis, W. P. (Los Alamos Scientific Lab., N. Mex.); Schwoebel, R. L. Contract W-7405-eng-36. Surface Sci., 11: 82-98(July 1, 1968). (LA-DC-9234).

A single crystal platelet of uranium dioxide has been prepared with one side very nearly parallel to the (111) plane and the other side inclined approximately 11.4° from the (111) plane. Low energy electron diffraction patterns obtained from the surface parallel to the (111) plane are characteristic of the clean unmodified uranium dioxide structure after the crystal has been vacuum annealed. Diffraction patterns from the inclined surface exhibit more closely spaced beams which are attributed to superstructures of regularly spaced steps. The observed patterns from the inclined surface have been compared to calculated diffraction patterns based on a simple kinematical analysis where it is assumed that the step height and spacing are in accord with a surface parallel to the (553) plane. Calculations have been made for the case in which only the outermost layer of uranium (or oxygen) atoms serve as scattering centers, and also for the case in which the contribution of the second layer equals that of the first. (auth)

36550 DYNAMIC MICROSCOPY OF CERAMIC NUCLEAR FUELS. Daniel, J. Leland Jr. (Battelle-Northwest, Richland, Wash.). pp 565-6 of Sixth International Congress for Electron Microscopy, Kyoto, 1966. Tokyo, Maruzen Co., Ltd., 1966. (BNWL-SA-698).

Experimental techniques have been developed and applied to plutonium and uranium ceramic fuels for the dynamic examination of materials while undergoing reaction at temperatures up to more than 2000°C. Three heating devices are available, wire-wound micro electric furnace, low voltage electron beam heater, and electrical self-resistance specimen stage, to permit comparison of heating modes. In addition, the microscope is fitted with a small gas jet at the specimen position, so that gas/solid surface reactions can be studied under controlled conditions. For plutonium work a small specimen-transfer glove box is attached to the microscope column, to facilitate handling of the toxic materials. Of particular interest is the comparative behavior of PuO_2 and W/UO_2, two potential reactor fuels, in the normal electron microscope vacuum of about 10^{-4} mm Hg. A series of several reactions, vaporizations and recrystallizations has been found in the W/UO_2 cermet. Beginning at about 600°C, a peripheral surface crystal structure develops on each UO_2 grain, along with a few elongated ridges in the center. As the temperature increases these surface crystallites alternately appear and evaporate, on both W and UO_2, until the UO_2 totally evaporates abruptly at about 1600°C. Marked outgassing of the remaining tungsten then occurs, giving the effect of vigorous boiling at 1800°C. Upon cooling the tungsten has extensively recrystallized, but no evidence exists for reaction at the W–UO_2 interfaces. The material behavior apparently is strongly influenced by impurities entrapped in the specimen during fabrication, especially since both the UO_2 and tungsten oxides are relatively volatile. By contrast, the $PuO_{1.82}$ exhibits only minor surface etching during initial heating. At about 1000°C an extensive surface reaction occurs rapidly; x-ray analysis showed that oxidation to $PuO_{2.09}$ by

residual air in the microscope takes place. If the column is first flushed with dry hydrogen, and a pressure of 5×10^{-3} mm of H_2 is maintained during microscopy, the oxidation does not occur. These experiments indicate that both fabrication methods and fuel components markedly influence the behavior of nuclear fuel specimens operating in reduced pressure or vacuum. (auth)

Radiation Effects

Refer also to abstracts 36513, 36514, and 36516.

36551 (BNWL–740) GRAPHITE IRRADIATIONS IN EBR-II: CAPSULES BG-1, BG-2, AND BG-3. Pitner, A. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 20p. Dep. CFSTI.

Nine grades of graphite were irradiated in the EBR-II reactor from 400 to 700°C to maximum exposures of 8×10^{21} nvt (E > 0.18 MeV). Three isotropic graphites showed good dimensional stability in the irradiations. Apparently, there is no adverse difference in the behavior of graphite irradiated in fast or intermediate reactors. The excellent agreement obtained between exposure calculated from the activation of nickel and iron flux monitors attests to the accuracy of the monitor cross sections and calculated neutron spectrum employed in determining the exposures. (auth)

36552 (GEAP–5100-10) FISSION GAS RELEASE FROM UO_2 IRRADIATED ISOTHERMALLY AT TEMPERATURES FROM 1500°C TO 2100°C. Esswein, G. A. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Mar. 1968. Contract AT(04-3)-189. 51p. (EURAEC–2034). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Fission gas release data were obtained for sintered UO_2 from four capsules which contained fuel test specimens irradiated at nominal temperatures of 1500, 1700, 1900, and 2100°C under nearly isothermal conditions. The original purpose of these irradiations was to better define the temperature-release fraction relationship in the temperature range between 1500 and 2100°C. Within this critical temperature range, the fraction of the fission gas that is released increases from less than one percent to virtually complete release, even during short-term irradiations. A unique capsule design with several separate fuel regions was developed for the experiments to minimize the axial temperature gradient in the test fuel specimen and maintain its radial gradient at a low, predetermined value. Thus, the specimen from which the fission gas release was to be measured operated at virtually isothermal conditions during irradiation. The capsule design also incorporated an automatic binary gas control system to hold temperature levels constant over a period of days, despite a continuous change in the neutron flux at the irradiation position in the GETR test reactor. The actual fission gas release data obtained from three of the four capsules were compromised by brittle fracture of the tungsten cladding that enclosed the UO_2 test specimens. However, the final test capsule design provided excellent performance in terms of achieving and maintaining the desired operating conditions. The capsule design aspects and the performance experience during irradiation are emphasized. (auth)

36553 (N–68-17095) SUMMARY OF RADIATION EFFECTS ON THERMIONIC INSULATOR MATERIALS. Mayer, John T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 37p. (NASA-TN-D–4414). CFSTI.

Nuclear thermionic power systems are presently being studied for possible space applications. One of the critical materials in such designs is the metal oxide ceramic used as an electrical insulator and seal between various components. Such materials must withstand high temperatures (1000°C and above) as well as fast neutron doses to 10^{22} neutrons per square centimeter. To gain insight into their behavior in such an environment, a literature survey has been conducted for radiation effects data on the following candidates: beryllia, alumina, thoria, zirconia, and yttria. The properties of interest include dimensional changes, thermal and electrical conductivity, strength, thermal expansion coefficient, elastic modulus, and breakdown voltage. A large amount of data were found on beryllia, but much less work has been done on the other oxides, especially zirconia, thoria, and yttria. Beryllia seemed to be the most promising material, and its radiation stability may be improved by the use of additives and/or fine-grained low-density material. However, the large gas production rate in beryllia may restrict its use in thermionic systems; the release of a significant amount of helium gas into the interelectrode space may affect converter performance. The most successful tests on beryllia to date showed relatively minor changes after fast neutron doses to 9×10^{21} neutrons per square centimeter at 1000°C. In contrast, high-temperature tests of alumina and yttria have resulted in gross fracturing at lower doses. No high-temperature, high-dose data on thoria or zirconia were found. (auth) (STAR)

Plastics and Other Materials

Refer also to abstracts 36513, 36516, and 37467.

36554 (BARC–322) COMPATIBILITY STUDIES ON VINYL PAINT. Srivastava, S. B.; Rama Rao, K. V. S.; Shastry, L. V.; Sarpotdar, A. S. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 9p. Dep.

A study was made of a Gaco vinyl paint for possible use to line steel tanks for D_2O storage. Isotopic exchange between D_2O and painted surfaces was investigated and found to be minimal; purities remained above 99.5% after a week. The change of pH of water in contact with the vinyl paint was negligible for the oven-dried paint, while the air-dried paint decreased it from 6.15 to 4.6 in 19 days. The uv absorption spectrum of the equilibrated water showed a peak at 250 mμ. No evidence was found for the formation of HCl after 15 days. The pH depression effects of ^{60}Co gamma rays on water in and out of contact with paint were identical; oven drying for 30 days suppressed the pH change. Recommendations are given for using the paint with D_2O. (D.L.C.)

36555 (LA–3890) POLYCARBONATE AS AN ADHESIVE. Newfield, S. E.; Ehart, E. P. (Los Alamos Scientific Lab., N. Mex.). Jan. 15, 1968. Contract W-7405-eng-36. 6p. Dep. CFSTI.

Injection-molding grade clear polycarbonate resin has been used as a hot-melt adhesive in several experimental bonding applications. The low creep, non-outgassing, and favorable heat-deformation properties of this resin, linked with its newly discovered adhesive properties, make polycarbonate an ideal adhesive in certain applications. (auth)

36556 (N–68-16474) EFFECT OF GAMMA RADIATION IN VACUUM ON THE TENSILE PROPERTIES OF POLYMER FILMS. Price, Howard L. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). [1967]. 26p. (NASA-TM-X–60858). CFSTI.

The tensile properties of polymer films have been measured in air after the films were exposed to gamma radiation in vacuum. The dose rate was approximately 1.6 megarads per hour for doses to 2,000 megarads at a pressure of 10^{-6} torr. Four 0.001-inch-thick films were tested: poly(ethylene terephthalate) (PETP); poly(cyclohexylenedimethylene terephthalate) (PCTP); poly(vinylidene fluoride (PVF_2); and a polyimide or (PI). The yield strength, tangent modulus, tensile strength, and elongation at break were obtained from the tensile tests. The average value and standard deviation of each property are given, based on the results of twenty-five tests at each dose. The data show the effect on the tensile properties of chain scission and cross linking, and indicate the useful dose range of the films subjected to ionizing radiation. (auth) (STAR)

36557 AMORPHOUS HYDRATED ZIRCONIUM OXIDE. PROTON NUCLEAR MAGNETIC RESONANCE STUDY OF ITS THERMAL BEHAVIOUR. Vivien, D.; Livage, J.; Mazieres, C. (ENSCP, Paris. Faculte des Sciences, Orsay, France). Bull. Soc. Chim. Fr., No. 4, 1307-13(Apr. 1968). (In French).

Wide line NMR experiments were performed to study water in amorphous precipitated zirconium oxide. This water seems to be weakly held on the surface of the particles. A very thin line appears in the spectrum of the samples when heated under vacuum. This suggests the presence of free water molecules enclosed in microcavities of the crystallized phase which occurs during heating. The shift of the lines with respect to the line of liquid water was studied in high resolution experiments. The dependence of these shifts on temperature can be explained by the diamagnetism of the solid and a paramagnetism attributed to localized centers. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 36812, 36762, 36763, 36772, 36773, 37196, and 37301.

36558 (N-68-10005) MICRO-SCALE STRUCTURES IN THE INTERPLANETARY MEDIUM. Burlaga, Leonard F. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Sept. 1967. 55p. (NASA-TM-X-65995; X-612-67-524). CFSTI.

Described and analyzed are the following micro-scale (≲.01 AU) structures which were found in combined interplanetary magnetic field and plasma data obtained by the deep space probe, Pioneer 6: (1) several types of simultaneous discontinuities in the magnetic field and plasma parameters; (2) at least one clear example of a transitional region (D-sheet) associated with a plasma discontinuity; (3) other D sheets which give evidence of magnetic field annihilation; (4) inhomogeneous isothermal regions in which the square of the magnetic field intensity is proportional to the density; and (5) periodic variations in the magnetic field intensity which are associated with discontinuities in the bulk speed. It is suggested that small velocity discontinuities play a fundamental role in reducing stresses in the interplanetary medium, and that large velocity discontinuities may give rise to waves and turbulence. (auth) (STAR)

36559 (N-68-10123) THE STRUCTURE OF JUPITER'S MAGNETOSPHERE AND THE EFFECT OF IO ON ITS DECAMETRIC RADIO EMISSION. Gledhill, J. A. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1967. 32p. (NASA-TM-X-55980; X-615-67-296). CFSTI.

A short discussion is given of the reasons for co-rotation of magnetospheres with their planets. It is shown that, if Jupiter's magnetosphere co-rotates, the plasma on any magnetic shell must tend to concentrate at those parts of the shell which are most distant from the rotational axis, because of the large centrifugal force. This would compress the plasma into a discus-shaped region about a planetary diameter thick, inclined to the equatorial plane by about 7°. The passage of this plasma over the satellite Io offers a new and attractive basis on which to explain the influence of Io on the decametric radiation of Jupiter. It is proposed that the maximum plasma frequency at Io's orbit is 40 MHz. Exploration of this possibility leads to a plasma temperature of 1800°K and a magnetic field of 30 gauss at Jupiter's equatorial surface, with the dipole displaced 0.4 planetary radius towards the north rotational pole. Some discussion of the difficulties of the theory is given and its future development is considered. (auth) (STAR)

36560 (N-68-10164) TABULATED COMMUNICATION CHARACTERISTICS OF A STEADY-STATE MODEL OF INTERPLANETARY SPACE. Hruby, Ronald J.; Somes, Austin H.; Dimeff, John; Tashjian, Howard (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). 1967. 526p. (NASA-SP-3042). CFSTI.

The changes in an electromagnetic wave as it passes through interplanetary and coronal space depend on the intervening plasma and magnetic fields. These changes are presented as a function of the transmission range and the view angle relative to the Earth–Sun line in the ecliptic plane. This information can be used to determine the total change in an electromagnetic wave between any two points in the Earth–Sun volume excluding the magnetosphere. Models for the electron density, the magnetic fields, and the solar wind were derived from the best available estimates and experimental data. Tabulated data are derived from a steady-state model of the coronal space corresponding to a simplified quiet Sun. The spiral pattern of the magnetic field model is considered to have no disordering effects, and the model of the electron density is a function of solar radial distance only. The interplanetary space is considered to be a neutral plasma with equal densities of electrons and protons. Communication between any two points within the Earth's orbit and in the ecliptic plane can be analyzed from the tabulated data. (auth) (STAR)

36561 (N-68-10375) COMPOSITION OF THE SEPTEMBER 2, 1966 SOLAR PARTICLE EVENT. Durgaprasad, N.; Fichtel, C. E.; Guss, D. E.; Reames, D. V. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). July 1967. 13p. (NASA-TM-X-63012; X-611-67-324). CFSTI.

Three Nike–Apache sounding rockets were launched from Manitoba, Canada, to study the composition and the characteristics of the September 2, 1966, solar flare event. These launches occurred approximately 9, 16, and 36 hours following the event. Nuclear emulsions were used to study all the components, namely, the singly, doubly, and multiply charged nuclei emitted in the solar event and propagated within the solar system. The helium nuclei were separated from protons by using grain density and range measurements and from multiply charged nuclei by δ-ray density and range measurements. The multiply charged nuclei were charge identified from δ-ray density and range measurements. The energies of these nuclei were mainly determined from their residual range in the emulsion. The energy spectra measured in the event are much steeper than those reported for events in which the composition studies were made previously. The measured ratio of helium to medium (C, N, O, F) nuclei for energies above 12.7 MeV/nucleon in the first flight is 54 ± 8. This value is in agreement with the previous measurements and this strongly supports the ideas held that the acceleration mechanism does not appreciably alter the spectroscopically observed abundance of the solar photosphere. (auth) (STAR)

36562 (N-68-10969) PRE-WHITE DWARF EVOLUTION. III. Vila, Samuel C. (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies). [1967]. 23p. (NASA-TM-X-60603). CFSTI.

Stars of masses between 0.2 and 1.2$M_{\odot}$ in those stages of their evolution in which the matter becomes degenerate were previously studied. The neutrino reactions were included and the sequences of models were stopped when the neutrino luminosity was too small to influence the further evolution and the formation of an ion lattice would invalidate the equation of state used. In the cores of dense white dwarfs the ions are arranged in a lattice. A simplified model is studied to calculate the changes in the thermodynamic properties due to the existence of a lattice of finite temperatures. This model takes into account the major correction term due to the electron–lattice interaction. The main purpose was to estimate the changes introduced in the cooling times of white dwarfs by the ion lattice. (auth) (STAR)

36563 (N-68-11005) PROTONS ASSOCIATED WITH CENTERS OF SOLAR ACTIVITY AND THEIR PROPAGATION IN INTERPLANETARY MAGNETIC FIELD REGIONS CO-ROTATING WITH THE SUN. Fan, C. Y.; Pick, M.; Pyle, R.; Simpson, J. A.; Smith, D. R. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). (NASA-CR-90227; EFINS-67-72). Aug. 1967. Contracts NAS2-3876; AF39(638)-1642. 67p. CFSTI.

The Pioneer-6 and Pioneer-7 space probes carried charged-particle telescopes which measure, for the first time, both the direction of arrival and differential energy spectra of protons and alpha particles. The intensity changes, directional distributions, and energy spectra of proton fluxes associated with solar activity were investigated. The data were obtained in the beginning of the new solar cycle (No. 20), when it is possible to unambiguously associate proton flux increases with specific solar active regions. The origin, possible long-term storage, and propagation of these proton fluxes were investigated. It was observed that enhanced 0.6 to 13-MeV proton fluxes associated with specific active regions were present over heliographic longitude ranges as great as ≈180°. These enhanced fluxes exhibit definite onsets and cutoffs which appear to be associated with the magnetic sector boundaries observed by Ness on Pioneer-6. (auth) (STAR)

36564 (N-68-15117) SOLAR ACTIVITY: A BIBLIOGRAPHY. Eckstein, Herbert P. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center. Army Missile Command, Redstone Arsenal, Ala.). Sept. 28, 1967. 176p. (NASA-TM-X-60851; RSIC-7061). CFSTI.

This bibliography contains 512 citations to articles on solar activity as evidenced by sunspots, flares, and cosmic and terrestrial effects. In addition, there are listed books dealing with solar activity, and observatory publications and other periodicals routinely reporting observational data and forecasts of periodic events. (auth) (STAR)

36565 (N-68-16118) RESULTS OF A SOUNDING ROCKET EXPERIMENT TO STUDY GALACTIC X-RAY SOURCES. Final Report, March 29–December 8, 1967. (American Science and Engineering, Inc., Cambridge, Mass.). Dec. 1, 1967. Contract NASw-1583. 90p. (NASA-CR-80280; ASE-1762). CFSTI.

To obtain information on galactic x-ray sources, an x-ray astronomy experiment was flown on the Aerobee rocket. The objectives were to determine whether any x-ray sources could

be identified with optical objects, to localize the x-ray sources grouped on the Sgr–Sco region of the Milky Way and to obtain spectral information on the x-ray emission of the sources. The tests conducted were an x-ray survey of the Cygnus Region, an optical search for the x-ray sources Cyg X-1 and Cyg X-2, distribution of galactic x-ray sources from Scorpio to Cygnus, and the spectra of several x-ray sources in Cygnus and Scorpio. An analysis of data show: (1) Cygnus A was not observed to emit x-rays, and none of the recorded x-ray sources coincided with any outstanding single objects in the area; (2) a candidata object was found for Cyg X-2 that has many of the optical properties of Sco X-1. The analyzed data from the observed spectra showed a deficiency of photons at low energy that could only be interpreted as absorption effects. (STAR)

36566 (N-68-16304) INFRARED OBSERVATIONS OF POSSIBLE PROTOSTARS. Becklin, E. E.; Neugbauer, G. (California Inst. of Tech., Pasadena). 1967. 12p. (NASA-CR-92724). CFSTI.

Observational data are presented on several infrared objects in the HII regions and gaseous nebulae, which radiate 80% or more of their energy at wavelengths longer than 2μ. A possible protostar, the R. Monocerotis (R. Mon) located at the head of the variable nebula, is described as having a visual component classified as a T. Tauri star and radiating energy beyond 2μ. Another object similar to the R. Mon and located in the Orion Nebula, radiates energy at 5μ. The properties of the nebula obtained from observations at 20μ include flux, density, luminosity, and brightness temperature. (STAR)

36567 (N-68-16582) A FOCUSING X-RAY TELESCOPE FOR HIGH-ALTITUDE OBSERVATIONS OF COSMIC X RAYS IN THE ENERGY RANGE 20 TO 140 keV. Lindquist, Thomas Russel (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Dec. 1967. 87p. (NASA-CR-92951; CR-110). CFSTI.

Thesis.

Details are given on the design and construction of an x-ray telescope for focusing hard x rays from a large collection area to a small focal area. Its lens consists of approximately 4000 rock salt crystals, chosen primarily for their relatively high reflecting power; measurement data on the reflectivity are given. Pertinent aspects of x-ray-diffraction theory are discussed. Two possible versions of the focusing x-ray telescope are compared with other x-ray detectors, and it is shown that the focusing telescope has the narrowest field of view, and greater sensitivity at 30 keV although this advantage diminishes rapidly with increasing energy. It is pointed out that the telescope's good sensitivity, especially in the 20- to 40-keV energy range where the flux detected at balloon altitudes is greatest, makes it well suited for collecting data on weak sources in short times or discovering new sources provided that it can be kept pointed accurately at the region of interest. (STAR)

36568 (N-68-22567) ASTROPHYSICAL PHENOMENA AND RADIOCARBON. Konstantinov, B. P.; Kocharov, G. E. Translated for National Aeronautics and Space Administration, Washington, D. C., from pp 1-43 of Astrofizicheskiye Yaveniya i Radiouglerod, Leningrad, 1967. 36p. (NASA-TT-F-11567). CFSTI.

Consideration is given to an expansion of the basic relationships between astrophysical phenomena and radiocarbon. Determination of the radiocarbon content in dendrochronologically dated samples is used to study solar cyclic activity, flares from supernovae, etc. In addition, the atmospheric C^{14} concentration can be used to determine the characteristic times for C^{14} dispersion into various reservoirs. (auth) (STAR)

36569 (N-68-22685) SUPERNOVAE EXPLOSIONS INDUCED BY PAIR PRODUCTION INSTABILITY. Fraley, Gary S. (California Inst. of Tech., Pasadena). Mar. 1968. 36p. (NASA-CR-94422). CFSTI.

Stars with a core mass greater than about 30 $M_\odot$ become dynamically unstable due to electron–positron pair production when their central temperature reaches 1.5 to 2.0×10^9 °K. The collapse and subsequent explosion of stars with core masses of 45, 52, and 60 $M_\odot$ is calculated. The range of the final velocity of expansion (3,400 to 8,500 km/sec) and of the mass ejected (1 to 40 $M_\odot$) is comparable to that observed for type-II supernovae. A dynamical model of convection is derived and included in the calculations. It was found that the effect of the convection on the explosions is probably not important. (auth) (STAR)

36570 (N-68-23026) AN ATLAS OF 10 TO 50 keV SOLAR FLARE X RAYS OBSERVED BY THE OGO SATELLITES, SEPTEMBER 5, 1964–DECEMBER 31, 1966. Arnoldy, R. L.; Kane, S. R.; Winckler, J. R. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Jan. 1968. Contract NAS5-2071. 82p. (NASA-CR-94429; CR-108). CFSTI.

Ionization rate profiles are presented for about 70 solar events that represent almost all of the cases detected by the ion chambers during the observing times of OGO-I and OGO-III through the end of 1966. Some data on the instrumentation are included for these preliminary studies relating to x-ray phenomena in radio emission. Besides listing of frequency and the observing station, the presence of the radio emission is indicated on the plots by a horizontal line with a vertical arrow marking the reported time of maximum. Although radio information is quite complete, the absence of an indicated radio burst in some cases is due to the unavailability of information and does not necessarily mean a radio burst did not occur. (STAR)

36571 THE BALMER DISCONTINUITIES OF PECULIAR AND MAGNETIC A STARS. Lyabin, V. M. (Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 979-81(May-June, 1968).

Translated from Astron. Zh., 44: 1224-7(Nov.-Dec., 1967).

Model atmospheres were constructed for Ap stars, assuming that the abnormally small values for the Balmer discontinuity in these stars result from temperature gradients that are lower than for normal A stars. The turbulent velocities necessary for convective energy transport to be adequate to maintain these gradients are calculated. (auth)

36572 AN ESTIMATE FOR THE MIXING LENGTH FROM STELLAR-VARIABILITY THEORY. I. ADIABATIC PULSATIONS IN MODELS OF δ CEPHEI AND RR LYRAE VARIABLES. Aleshin, V. I. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 982-9(May-June, 1968).

Translated from Astron. Zh., 44: 1228-38(Nov.-Dec., 1967).

Models were constructed for the envelopes of δ Cephei and RR Lyrae variables in which radiative energy transfer is accompanied by convective transfer. The models differ in having various values for the mixing length. Solutions of the boundary-value problem for the adiabatic-pulsation equations were found for each model. (auth)

36573 INTERPRETATION OF ECLIPSING SYSTEMS AS AN INVERSE PROBLEM OF PHOTOMETRY. Cherepashchuk, A. M.; Goncharskii, A. V.; Yagola, A. G. Sov. Astron. AJ (Engl. Transl.), 11: 990-9(May-June, 1968).

Translated from Astron. Zh., 44: 1239-52(Nov.-Dec., 1967).

The problem of interpreting eclipsing binary systems is treated as a special case of the general problem, the "inverse problem" of photometry. Two cases are considered: a classical and a semi-classical model. It is shown that in these cases total and "not too partial" ($\cos i < r$) eclipses are described by a closed system of equations for the parameters and functions describing the photometric properties of the components. An application of the "regularization method" to narrow-band light curves of the system V444 Cygni in the continuum (at λλ 4795, 4440, and 4260 Å) enables the physical functions and geometric parameters to be determined to good accuracy. An analysis of the results confirms the electron-scattering hypothesis. The distribution of electron density in the extended atmosphere of this Wolf–Rayet star is derived; it is well approximated by an exponential relation. The wavelength dependence of the emitting properties of the Wolf–Rayet star is established, and several of its characteristics are determined. (auth)

36574 PHOTOMETRIC ELEMENTS, ABSOLUTE DIMENSIONS, AND MASSES FOR THE ECLIPSING SYSTEM RR LYNCIS. Botsula, R. A. (Engel'gardt Astronomical Observatory, Kazan). Sov. Astron. AJ (Engl. Transl.), 11: 1000-5(May-June, 1968).

Translated from Astron. Zh., 44: 1253-60(Nov.-Dec., 1967).

Photometric elements, absolute dimensions, and masses for the eclipsing binary RR Lyncis, one of whose components is a "metallic" star, are calculated from data observed photoelectrically at the Engel'gardt Observatory. The mass of the metallic star is more likely smaller, not larger, than the average value for main-sequence stars of the same spectral type; its radius is about 1 $R_\odot$ larger than average, and its density is about four times smaller than average. (auth)

36575 STRUCTURE AND MASS OF SUPERNOVA, QUASAR, AND SEYFERT-GALAXY ENVELOPES. Gordon, I. M. (Inst. of Radiophysics and Electronics, Kiev). Sov. Astron. AJ (Engl. Transl.), 11: 920-7(May-June, 1968).

Translated from Astron. Zh., 44: 1146-56(Nov.-Dec., 1967).

An analysis of the observed radio-brightness distribution in the source 3C 273B indicates that scattering processes involving a nonlinear interaction of transverse (electromagnetic) and longitudinal (plasma) waves take place in its envelope. By taking account of these nonlinear interactions one can estimate an upper bound on the electron concentration and the mass of the envelope in many objects that contain a nucleus of small angular size.

Among these are the Seyfert galaxy NGC 1275, the Crab Nebula, 3C 273B, and several other quasars. It is concluded that the emission spectrum of these objects arises in gaseous filaments embedded in a highly rarefied amorphous mass with $n_e \gtrsim 10^{-2}$ cm^{-3}; if the concentration were any higher the apparent angular size of the nucleus would be greater because of the nonlinear scattering processes. The circumstance that the type II supernova envelope HB 21 falls in the same line of sight as 3C 418, an extragalactic source of small angular size, is used to obtain the estimate $M \leq 0.4 M_\odot$ as an upper bound on the mass of the envelope. (auth)

36576 PRELIMINARY RESULTS OF 2.11-mm OBSERVATIONS OF DISCRETE RADIO SOURCES. Kislyakov, A. G.; Naumov, A. I. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 1059-60(May-June, 1968).

Translated from Astron. Zh., 44: 1324-6(Nov.-Dec., 1967).

The results are reported of measurements of the radio flux density S of the sources Vir A, Sgr A, and Tau A at 2.11-mm wavelength. For Vir A, $S \leq 5 \cdot 10^{-24}$ $W/m^2 \cdot Hz$. In the same units the sources Sgr A and Tau A have flux densities of 7.5 ± 4 and 28 ± 9, respectively. (auth)

36577 OSCILLATORY CONVECTION OF A CONDUCTING GAS IN A STRONG MAGNETIC FIELD. Syrovatskii, S. I.; Zhugzhda, Yu. D. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 945-52(May-June, 1968).

Translated from Astron. Zh., 44: 1180-90(Nov.-Dec., 1967).

It is shown that when an inhomogeneous compressible medium is subjected to a strong vertical magnetic field, a new type of convective instability will arise if the temperature gradient is sufficiently large. Slow magnetosonic oscillations of the gas along the magnetic field will then develop. Because of its compressibility the gas will rise along the field into cooler regions and will relinquish some of its energy through radiative heat conduction. This last process will be quite efficient because of the small transverse diameters of the convection cells, which are strongly distended along the field. The instability criterion does not contain the magnetic-field strength, so that the oscillatory convection examined here can develop in arbitrarily strong magnetic fields. For large values of the polytropic index, the instability criterion for oscillatory convection is less severe than the Schwarzschild criterion for a compressible medium in the absence of a magnetic field. The possible role of oscillatory convection in transporting heat within sunspots and in forming active regions is discussed. (auth)

36578 MEASUREMENTS OF SOLAR RADIO EMISSION AT MILLIMETER AND SUBMILLIMETER WAVELENGTHS. Fedoseev, L. I.; Lubyako, L. V.; Kukin, L. M. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 953-5(May-June, 1968).

Translated from Astron. Zh., 44: 1191-3(Nov.-Dec., 1967).

Solar radio emission was measured at wavelengths of 0.74, 0.87, 1.06, 1.24, 1.26, and 1.45 mm. The equipment, techniques, circumstances, and results are described briefly. The data obtained are compared with measurements made at other wavelengths. (auth)

36579 RADIO EMISSION FROM BEAMS OF FAST PARTICLES UNDER COSMIC CONDITIONS. Kaplan, S. A.; Tsytovich, V. N. (Gorky State Univ., USSR. Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 956-64(May-June, 1968).

Translated from Astron. Zh., 44: 1194-1205(Nov.-Dec., 1967).

A system of spectral equations is derived and solved numerically for determining the spectra of the plasma and electromagnetic waves excited by beam instability. The effect of nonlinear scattering by ions is taken into account. The intensity of the electromagnetic radiation in this system is determined. The results may be used for interpreting type-III bursts of solar radio emission and other objects in which beams of fast particles are formed. (auth)

36580 MAGNETOHYDRODYNAMIC EFFECTS IN COMETS. Ioffe, Z. M. (Tadzhik State Univ., Dushanbe, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 1044-7(May-June, 1968).

Translated from Astron. Zh., 44: 1304-8(Nov.-Dec., 1967).

The general situation of the flow around a comet of solar wind carrying a magnetic field is considered. The "collapse" of the rays is explained by the velocity gradient in the flow behind the shock wave. The acceleration imparted to the plasma when particles are "squeezed" out of the magnetic tubes of force (the ray model) is determined; its value agrees with observational data. A narrow region of enhanced magnetic field develops at the interface between the comet and the solar wind. (auth)

36581 INTERPRETATION OF OBSERVATIONS OF CO LINES IN THE SOLAR SPECTRUM. Livshits, M. A.; Polonskii, V. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow. Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 965-8(May-June, 1968).

Translated from Astron. Zh., 44: 1206-10(Nov.-Dec., 1967).

Observations of the lines of the CO molecule in the 2.3-μ region yield the estimate $N_{CO} \approx 3 \times 10^{19}$ cm^{-2} for the number of CO molecules, which agrees with the photospheric value $P_g \approx 3 \times 10^4$ $dyne/cm^2$ for the gas pressure in the layer where the molecules are formed. In order for these values to agree with the turbulent velocities of ≈ 3 km/sec in the molecular layer, one must assume that cool, dense condensations exist at the base of the chromosphere. The behavior of the CO lines in faculae is also discussed. (auth)

36582 TIME DEPENDENCE OF THE MAGNETIC-FIELD STRENGTH OF SUNSPOTS. Ikhsanov, R. N. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 969-75(May-June, 1968).

Translated from Astron. Zh., 44: 1211-19(Nov.-Dec., 1967).

The problem of the variation in the magnetic-field strength of sunspots from the time of their formation until their disappearance is discussed. The field strength H_m of a spot varies with time in parallel with the change in the spot area, but the amount of change in H_m is smaller for spots of large area. (auth)

36583 A COMPARISON OF THE PULKOVO AND GREENWICH SUNSPOT CATALOGS. Gnevysheva, R. S. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 976-8(May-June, 1968).

Translated from Astron. Zh., 44: 1220-3(Nov.-Dec., 1967).

The areas of sunspot groups as given in the Pulkovo and Greenwich catalogs for 1949 and 1958 are compared. A linear and very close relationship is found. The ratio of the areas for spots in the Pulkovo and Greenwich catalogs may be considered practically constant and equal to unity. The Pulkovo catalog may be used along with the Greenwich catalog without conversion factors of any kind. (auth)

36584 EXPLANATION FOR THE ALBEDO DIFFERENCES ON THE MOON. Levin, B. Yu.; Radlova, L. N. (Inst. of Earth Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 1034-43 (May-June, 1968).

Translated from Astron. Zh., 44: 1296-1303(Nov.-Dec., 1967).

Even though the lunar "continents" are composed to a greater extent than the maria of basic rocks — rocks which darken more strongly under the action of the solar wind, they are brighter than the maria. This effect results from differences in the mean slope angle of the surface relief. The greater the slope angle, the greater will be the rate with which the outer layer is intermixed and particles darkened under the action of the solar wind are buried, and the rate with which they are transported down the slope. Thus if other conditions are the same, the steeper the slope, the higher will be its albedo. The observed albedo is a mean value for larger or smaller areas and depends on the mean slope angle of the microrelief of these areas (both those visible and those invisible from the earth) and on the length of exposure of the outer layer to the action of the solar wind. In the great majority of cases these are the factors that determine the albedo; only occasionally are chemical differences manifested (craters with a dark nimbus and other such formations). (auth)

36585 CHANGE IN THE RADIO SPECTRUM OF ACTIVE REGIONS WITH PASSAGE BEHIND THE SOLAR LIMB. Abbasov, A. R.; Akhmedov, Sh.; Grebinskii, A. S.; Molchanov, A. P. (Shemakha Astrophysical Observatory, Leningrad. Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.), 11: 1061-2(May-June, 1968).

Translated from Astron. Zh., 44: 1326-8(Nov.-Dec., 1967).

When a sunspot group crosses into the invisible hemisphere of the Sun the spectrum of the local radio source associated with the group changes sharply: the maximum of the spectrum shifts from centimeter wavelengths to the long-wave region. (auth)

36586 OBSERVATIONS AND INTERPRETATION OF THE ULTRAVIOLET RADIATION OF THE GALAXY. Kurt, V. G.; Syunyaev, R. A. (Shternberg Astronomical Inst., Moscow. Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 928-31(May-June, 1968).

Translated from Astron. Zh., 44: 1157-61(Nov.-Dec., 1967).

Measurements by the automatic interplanetary stations (AIS) "Venus 2" and "Venus 3" have revealed the presence of emission in the spectral region 1225 to 1340 Å and in the L_α line in the direction of the Milky Way. The measurements in the spectral region 1225 to 1340 Å (an intensity of 3×1^{-7} $erg/cm^2 \cdot sec \cdot ster$,

or $F_\lambda \sim 3 \times 10^{-9}$ erg/cm^2 · sec · ster · Å) are explained as being the composite radiation of the Galaxy and give 1.5×10^{-2} for the intensity ratio $F_\lambda(1300)/F_\lambda(5560)$. It is shown from interstellar extinction calculations that the ratio of the volume emittances of Pop. I stars is $j_\lambda(1300)/j_\lambda(5560) = 4 \cdot 10^{-2}$ instead of the calculated 5.9. The upper limit obtained for the ultraviolet (1225 to 1340 Å) luminosity of the galaxy is 2×10^{40} erg/sec. It is also shown that the background from the external galaxies in the ultraviolet does not exceed 10^{-24} erg/cm^2 · sec · ster · Hz. It is possible that the L_α emission is not of galactic origin, since the known sources of L_α radiation in the galaxy cannot, owing to the extinction by dust, provide the observed intensity. An explanation of the observations is proposed which involves the reemission of solar L_α quanta by interplanetary hydrogen. The necessary increase in the density of the plasma up to that in the Milky Way may be associated with the regular galactic magnetic field. (auth)

36587 TYPE AND ABSOLUTE-MAGNITUDE DISTRIBUTIONS OF GALAXIES CONTAINING SUPERNOVAE. Pskovskii, Yu. P. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 914-19(May-June, 1968).

Translated from Astron. Zh., 44: 1139-45(Nov.-Dec., 1967).

The frequency with which supernovae of the standard types are encountered in different types of galaxies is considered. The mean integrated absolute photographic magnitudes of galaxies in which supernova outbursts have occurred are determined. The relative number of type Sc systems in which type I supernovae have been observed declines exponentially with transition from bright- to faint-luminosity galaxies. In order to evaluate the relative completeness of discovery in the Palomar supernova search, the apparent magnitudes of the galaxies containing the supernovae are used rather than estimates for the brightness of the supernovae at maximum light; the search is found to have been more complete than previously believed. (auth)

36588 POSSIBILITIES OF CLOSE ENCOUNTERS OF GALAXIES. Tomozov, V. M. (Shternberg State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 1020-3(May-June, 1968).

Translated from Astron. Zh., 44: 1280-3(Nov.-Dec., 1967).

The problem of the frequency of close encounters of galaxies in the clusters Coma Berenices, Virgo, and in a general field is considered, taking into account their gravitational interaction. (auth)

36589 DYNAMICS OF GALACTIC PLASMA. I. Pratap, R. (Univ. of Texas, Austin). Can. J. Phys., 46: 1257-71(June 1, 1968).

An answer to the question as to whether there could be a topological configuration of the magnetic field, velocity field, and a potential field which could retain the galactic plasma in the spiral arm in a self-consistent way is proposed. In the kinematic theory developed here, one does not have an external magnetic field such as an intergalactic field, but has only the internal magnetic fields generated by the motion of the plasma as such. The kinetic equations were applied to a galactic plasma rather than the fluid equations as is usually done; and, assuming a general quadratic expression for the distribution function in the velocity space, we have looked for the complete class of self-consistent magnetic fields, potential fields, as well as density distributions. Many important features of the magnetic fields are brought out and discussed at length. It is found that the "frozen-in" condition is valid for such a low-density plasma as well. (auth) (Canada)

36590 MEASUREMENTS OF THE TEMPERATURE OF THE PRIMORDIAL BACKGROUND RADIATION AT 8.2 mm WAVELENGTH. Puzanov, V. I.; Salomonovich, A. E.; Stankevich, K. S. (Lebedev Inst. of Physics, Moscow. Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 905-6(May-June, 1968).

Translated from Astron. Zh., 44: 1129-30(Nov.-Dec., 1967).

The results of absolute measurements of the primordial radio emission at 8.2-mm wavelength are reported. The radio telescope was calibrated by replacing a reference screen cooled to the temperature of liquid nitrogen with a screen having the temperature of the ambient air. The effective temperature at 8.2-mm wavelength was found to be 2.9 ± 0.7°K (rms error). This result confirms the Planckian character of the primordial radiation as far as 8-mm wavelength. (auth)

36591 COLLECTIVE PROCESSES IN BOUNDED GRAVITATING SYSTEMS. Maksumov, M. N. (Astrophysics Inst., Dushanbe, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 1015-19(May-June, 1968).

Translated from Astron. Zh., 44: 1274-9(Nov.-Dec., 1967).

A discussion is given on collective processes in gravitating systems, with allowance for the finite value of the parabolic velocity. The results obtained for systems with a nontruncated velocity distribution are generalized. (auth)

36592 FRAGMENTATION OF MATTER IN A TURBULENT METAGALACTIC MEDIUM. I. Ozernoi, L. M.; Chernin, A. D. (Lebedev Inst. of Physics, Moscow. Ioffe Inst. of Physics and Tech., Leningrad). Sov. Astron. AJ (Engl. Transl.), 11: 907-13 (May-June, 1968).

Translated from Astron. Zh., 44: 1131-8(Nov.-Dec., 1967).

Metagalactic turbulence represents an alternative to a strictly homogeneous and isotropic mass distribution during the early stages in the expansion of the Universe. The conditions under which it could be realized are discussed. Photon turbulence would probably provide a reservoir for turbulizing the metagalactic gas prior to its fragmentation. The dissipation of turbulent motions could form an efficient source of heating for the metagalactic gas during the pregalactic epoch. The relationships among the physical parameters of galaxies implied by the concept of a turbulent past for the metagalaxy are discussed briefly. The detection of irregularities in the primordial microwave radiation would provide an observational test of this hypothesis. (auth)

36593 STUDY OF THE DYNAMICS OF TRIPLE SYSTEMS BY MEANS OF STATISTICAL SAMPLING. Agekyan, T. A.; Anosova, Zh. P. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.), 11: 1006-14(May-June, 1968).

Translated from Astron. Zh., 44: 1261-73(Nov.-Dec., 1967).

Trajectories in the plane problem of three bodies with equal masses were calculated on an electronic computer. Altogether 100 different initial conditions were examined. The initial configurations were assigned by means of random numbers. The initial velocities of the component bodies were assumed to have the same small values in all cases. For 62 of the initial conditions the computations were carried to completion, and their accuracy was found satisfactory. In all these the motion was concluded by disintegration of the system. In every instance disintegration occurred after a close triple approach of the components. The mean disintegration time for a triple system (having negative energy and a small angular momentum), as computed from the results for 59 systems, is 62 ± 10 time units, where the unit is the mean time required for a component to cross the system. This corresponds to a mean disintegration time of $(1.6 \pm 0.3) \cdot 10^6$ yr for triple systems having masses of one solar mass and a mean distance of 0.03 pc between components. A triple galaxy with components of mass $2 \cdot 10^{43}$ g and a mean distance of 30 kpc between components would disintegrate, on the average, in 16 billion years. A diagram illustrates the motions of the components in one of the systems investigated, from the start of the motion until disintegration. (auth)

36594 THE ENIGMATIC PULSARS: FACTS AND INTERPRETATION. Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Inst. for Space Studies, New York); Maran, Stephen P. Sky Telesc., 36: 4-9(July 1968).

A report is given on the meeting at New York City on May 20–21, 1968. Reports from observatories and theoretical interpretations were included in the two day meeting. A summary of some length is presented of the proceedings. (W.D.M.)

36595 SPECTRA OF TWO CURRENT NOVAE COMPARED. Sky Telesc., 36: 16-17(July 1968).

At McDonald Observatory in Texas, the 82-inch Otto Struve reflector was used to photograph the spectra of Nova Delphini and Nova Velpecula on April 20, 1968, when the stars were of about magnitude 5. The two spectra are reproduced. (W.D.M.)

36596 MAGNETIC AND RELATED STARS. Hack, Margherita (Astronomical Observatory, Trieste, Italy). Sky Telesc., 36: 18-22(July 1968).

The general state of affairs concerning the Ap and Am (peculiar and metallic-line) stars, as indicated by the Cameron book (The Magnetic and Related Stars), is reviewed. Also, since the book was written over two years ago, some new results are added that modify, in part, conclusions reached then. Magnetic and related stars represent about 15% of all stars of the same range in color. (W.D.M.)

36597 THERMAL INSTABILITY IN A NUCLEAR-BURNING SHELL OF STARS. Hoshi, Reiun (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 957-83(Apr. 1968).

The criterion for instability that appears in a nuclear burning shell of stars and the evolution during the period of this instability were studied in general. It is shown without detailed numerical calculations that the temperature at the unstable shell increases until it reaches a certain maximum value, and afterward it decreases gradually. The maximum value of the temperature depends on the ratio of the radiation pressure to the total pressure of the nuclear burning shell at a stage when the instability begins.

The evolution during the instability was calculated in detail for four stellar configurations, including the stars with an unstable hydrogen-burning shell, an unstable helium-burning shell, an unstable carbon-burning shell and with an unstable hydrogen-burning shell which has been made by the accretion of a hydrogen-rich gas. (auth)

36598 THE SOLAR WIND. PART II. DYNAMICS OF STELLAR WINDS. Stodolkiewicz, Jerzy. Postepy Astron., 16: 87-96(1968). (In Polish).

The problems of dynamical features of stellar winds are considered. In particular, the number of independent parameters in equations of motion is discussed. (auth)

36599 DISTANCE AND PHYSICAL PROPERTIES OF 3 C 273. Haemeen-Anttila, K. A. (Univ., Oulu, Finland). Ann. Acad. Sci. Fenn., Ser. A VI, No. 260, 16p.(1967).

Distance and physical parameters of the star-like component of 3 C 273 are estimated by assuming that this object consists of one single radially symmetric body which is in mechanical equilibrium. Its distance turns out to be 2 Mpc and mass almost 10^{11} solar masses. Low effective temperature suggests that the spectral lines are not produced by thermal effects but by capture of electrons accelerated in electromagnetic field. Most of the redshift has a gravitational origin, but owing to the large size of the object (radius 10^{27} cm), no difficulties with its atmospheric electron density are encountered. (auth)

36600 SOME RESULTS OF THE RADIOEMISSION INTENSITY MEASUREMENTS AT A FREQUENCY OF 1.68 MHz ON THE BASIS OF DATA OBTAINED WITH THE KOSMOS-142 SATELLITE. Burenin, A. N.; Getmantsev, G. G.; Mityakov, N. A.; Rapoport, V. O.; Siz'min, A. M.; Tyukin, V. N. Kosm. Issled., 6: 313-15 (Mar.-Apr. 1968). (In Russian).

Radioemission intensity measurements, carried out with a 1.68 MHz receiver installed on the Kosmos-142 satellite during February 16 and 17, 1967 revealed a number of maxima ranging from plasma to hybrid resonances. The values were obtained while the satellite was at a height of 700 to 950 km. The broad maximum at the apogee was attributed to cosmic radiation; however, the effect of the ionospheric plasma on the antenna reduced the level of the input signal. Taking this effect into account on the basis of the method developed by D. Walsh et al., the level of the cosmic radioemission in vacuum was found to be 2.2×10^7 degree · ohm. The calculations also indicated values for the effective temperature and cosmic radioemission intensity of $T_{eff} = 7.1 \times 10^{6}$°K and $I = 6.2 \times 10^{-21}$ $wm^{-2}Hz^{-1}$ $sterad^{-1}$, at a mean error of ±35%. The results agreed with those obtained by means of the Electron-2 and Electron-4 satellites. (TTT)

36601 FOUR-FREQUENCY CLASSIFICATION OF SOLAR RADIO BURSTS. Tsimakhovich, N. P. (Radio Physical Observatory, Riga). Latv. PSR Zinat. Akad. Vestis, No. 4, 57-9 (1968). (In Russian).

A four-frequency classification is introduced for the conversion of monochromatic data into spectral types of radio bursts. (auth)

36602 SOLAR ROTATION AND THE PERIHELION ADVANCE OF MERCURY. Anand, S. P. S.; Fahlman, G. G. (Univ. of Toronto). Icarus, 8: 492-502(May 1968).

Uniformly rotating polytropic solar models are used to determine the implications of the observed solar oblateness for the perihelion advance of Mercury. In view of the hypothesized rapidly rotating solar interior, the second-order theory of rotating polytropes was used to study rotational effects up to terms of the order ω^4, where ω is the angular velocity of rotation. It is shown that the observed oblateness necessitates a rapidly rotating core if the surface of the Sun is an equipotential surface. In terms of a simple solar model in which the radiative core and the convective envelope are dynamically distinct regions, it is shown explicitly that the core must be rotating approximately 15 times faster than the surface and also possess an oblateness of 2×10^{-3}. On the other hand, the calculations show that by regarding the core and the envelope as a single dynamical entity, it would be possible to explain the observed oblateness if the angular velocity of the Sun were only about 2.5 times the observed surface velocity. The corresponding quadrupole moment of the Sun and the corresponding perihelion advance of Mercury would be much smaller than that of the decoupled model. Other implications of having a modestly fast rotating core are also briefly discussed. (auth)

36603 GALAXIES AND QUASARS AT PRAGUE. II. Page, Thornton L. (Wesleyan Univ., Middletown, Conn.). Sky Telesc., 35: 16-20(Jan. 1968).

A short summary is given of the findings reported at Prague on masses and luminosities of galaxies, clusters of galaxies, and extragalactic x rays. (W.D.M.)

36604 RANDOM WALK OF MAGNETIC LINES OF FORCE IN ASTROPHYSICS. Jokipii, J. R.; Parker, E. N. (Univ. of Chicago). Phys. Rev. Lett., 21: 44-7(July 1, 1968).

The importance of the random fluctuations in astrophysical magnetic fields is pointed out, which lead among other things to rapid diffusion of energetic particles across the average magnetic field. Application to the interplanetary magnetic field leads to a theory in which the field-line random walk, measured by the observed power spectrum of field fluctuations, is in agreement with that deduced from the observed turbulent motions in the solar photosphere. The two determinations agree well with the recently observed spread in longitude of low-energy particles released at the Sun. (auth)

36605 DEPENDENCE OF JOVIAN DECAMETRIC RADIO EMISSION UPON THE POSITIONS OF THE FIRST THREE GALILEAN SATELLITES OF THE PLANET. Tiainen, Pentti O. Ann. Acad. Sci. Fenn., Ser. A VI, No. 264, 39p.(1967).

Statistical analysis of the Jovian radio data obtained in 1960–1965 by the High Altitude Observatory at Boulder, Colorado, shows that the probability of emission is determined by the position of Io with respect to the magnetic axis of the planet, and that the most favorable positions of Io depends upon the frequency of emission. Moreover, it is indicated that the probability of emission at frequencies below 15 MHz is greatly increased when the position of the satellite Europa, in relation to the Sun and the planet, is favorable. The paper contains a discussion of the probability that the emission is also related to the position of the satellite Ganymede with respect to the Sun. (auth)

36606 INFLUENCE OF THE TEMPERATURE DEPENDENCE OF LUNAR MATERIAL PROPERTIES ON THE SPECTRUM OF THE MOON'S RADIO EMISSION. Troitskii, V. S.; Burov, A. B.; Alyoshina, T. N. (Gorky State Univ., USSR). Icarus, 8: 423-33 (May 1968).

Calculation of the thermal regime and radiation of the Moon was made, taking into account the temperature dependence of the specific heat, thermal conductivity, and absorption coefficient of the material. It is shown that the temperature dependence of the specific heat, typical of silicates, leads to a decrease of the calculated nighttime temperature of the Moon by 5 to 6°K. When the thermal conductivity varies 1.5 time in the interval 0 to 300°K, the temperature dependence of the thermal conductivity increases the nighttime temperature by 3 to 4°K and that during the shade phase of eclipse by 5 to 6°K. The only one considerable effect caused by the temperature dependence of the thermal conductivity is the growth of the constant component of the temperature up to the depth of 10 to 15 cm. As a result of it, the constant component of radiation increases with the growth of wavelength up to $\lambda = 1.5$ to 2 cm. The linear temperature dependence of the absorption coefficient which is typical of silicates produces an increase of the constant component of radiation with the maximum 10 to 20° at 0.1 to 0.2 cm wavelengths. It is concluded that precision measurements of the constant component of radiation on 2 to 3 cm, 0.1 to 0.2 cm wavelengths, and infrared waves are needed for determining the temperature dependence of the thermal conductivity and absorption coefficient. (auth)

36607 PROPER MOTION AND ABSOLUTE LUMINOSITY OF THE SHELL STAR P CYGNI. van Schewick, H. (Univ., Bonn). Z. Astrophys., 68: 229-34(1968). (In German).

The absolute proper motion of the variable shell star P Cygni was determined and compared with the motion of the open cluster IC 4996 and the association Cygnus OBI. P Cygni is not a runaway star of IC 4996. According to the proper motion and radial velocity, the star is a probable member of the OB association. It follows that the absolute magnitude is $M_v = -8.1$; the luminosity class is B1 Ia-0. (auth)

36608 ASSOCIATION II PUPPIS AND THE DELTA CEPHEI VARIABLE AQ PUPPIS. Grubissich, C. (Univ., Basel). Z. Astrophys., 68: 176-80(1968). (In German).

In a rediscussion of a paper by Fernie, Hiltner, and Kraft it is shown that the H-Gamma Method does not lead to a reliable distance for II Puppis. The luminosity calibration of the MK-classification according to Weaver and Ebert yields a true distance modulus of $(m - M) = 12^m.5$ and the UBV-method a value of $12^m.3$. Therefore the cepheid AQ Pup, whose distance modulus is $12^m.2$ or according to Sandage and Tammann $12^m.56$, may be a physical member of the association II Pup. (auth)

36609 BROADENING OF LITHIUM LINES BY MICROFIELDS. von der Heyde, Ruediger; Kusch, Hans Juergen (Univ., Kiel). Z. Astrophys., 68: 1-8(1968). (In German).

Line broadening of 4 neutral lithium lines by microfields was measured observing side-on the plasma flame protruding from a

pulsed lithium hydride capillary discharge. The results are compared with quantum mechanical calculations as well as with values obtained by classical impact theory and static Stark effect patterns. (auth)

36610 NOTE ON THE SPECTRUM OF NOVA HERCULIS 1960. Hidajat, Bambang (Hamburger Sternwarte, Hamburg). Z. Astrophys., 68: 164-6(1968).

In the period between March 22 and September 5, 1960 a series of spectra of Nova Herculis 1960 was secured with the Hamburg Observatory 1-m telescope. On the Hamburg films the main features of the spectra were identified by measuring the lines in comparison with the standard iron arc spectrum. In cases where doubtful features existed, a microphotometer tracing was performed. The intensities of the lines were estimated visually and are given. Scantiness of the calibration spectra made it impossible to obtain absolute intensity ratios. (W.D.M.)

36611 THE PERIOD OF δ CETI SINCE 1900. van Hoof, A. (Astronomical Inst., Louvain, Belg.). Z. Astrophys., 68: 156-63 (1968).

A review is given of all the radial velocity and magnitude observations made of δ Cet since the beginning of the century. Some of them are rediscussed. Photoelectric observations made at the Boyden Observatory are reported for the first time. It appears that up to the limits set by the observational errors all the spectroscopic and photometric data are satisfactorily accounted for by a period of $0^d.1611366$ which has remained constant over the whole time interval considered. (auth)

36612 EVOLUTION IN CLOSE BINARY STAR SYSTEMS. IV. SEQUENCES OF INHOMOGENEOUS STELLAR MODELS APPROXIMATING POSSIBLE REMNANTS AFTER RAPID MASS LOSS. Giannone, P. (Osservatorio Astronomico, Rome); Kohl, K.; Weigert, A. Z. Astrophys., 68: 107-29(1968).

Sequences of inhomogeneous equilibrium models were calculated for stars which have central hydrogen or helium burning. The varying parameters are the stellar mass, the mass of the hydrogen-rich envelope, and the central hydrogen content. These models approximate possible remnants of original primary components in the medium and low mass range after a rapid mass loss which starts during or after central hydrogen burning. Examples are given for the use of these sequences and results are compared with observations. (auth)

36613 α^2CVn AND THE MODIFIED SOLAR MODEL FOR MAGNETIC STARS. Tuominen, Jaakko; Tuominen, Ilkka V.; Malm, Kaj (Univ., Helsinki). Z. Astrophys., 68: 98-106(1968).

It is shown how the various regularities observed in the magnetic intensity, luminosity, line intensities, and radial velocities of α^2CVn can be explained on the basis of the modified solar model suggested in a previous paper. Comparison is made with other magnetic stars, especially HD 188041. (auth)

36614 LIMITING TEMPERATURE AND DYNAMIC INSTABILITY OF RED GIANTS. Kamijo, F. (Tokyo Univ.). Z. Astrophys., 68: 9-20(1968). (In German).

The limiting temperatures (the theoretical minimum effective temperature) for red giant stars of 1 $M_\odot$ were calculated with the assumption l = 1.5 H. The opacity used includes the band absorption of water vapor. The result is shown and is compared to similar calculations by Auman and Bodenheimer, 1967, and to observations by Mendoza and Johnson, 1965. The limiting temperatures are consistent with Auman's calculations but not with the observations shown. Possible reasons for this discrepancy are discussed. The adiabatic pulsation of envelope models for red giant stars (M = 1 $M_\odot$; L = 5,000 $L_\odot$, 10,000 $L_\odot$) was calculated in order to investigate the possible dynamical instability in such stars. The result is shown. It was found that instability occurs in very cool stars which lie near the limiting temperature line in the H–R diagram. This instability seems to correspond to that found in pre-main-sequence contraction. (auth)

36615 PULSATION OF STARS AFTER LARGE MASS LOSS DURING THE EVOLUTION OF WHITE DWARFS. Kamijo, F. (Tokyo Univ.). Z. Astrophys., 68: 21-8(1968). (In German).

The period of radial pulsation and its stability is calculated for a star which is a primary component in a close binary system, and after mass loss passes through the Cepheid strip in the H–R diagram on its way to become a white dwarf (Kippenhahn, Kohl, Weigert, 1967). The maximum instability occurs at T_e = 6500°K on the evolutionary track. The period of the pulsation is 1.12 days, which is 6.3 times as long as expected from the normal period–luminosity relation. It is shown that this long period comes from the following two effects: 1. The mass of the star is 1/9.5 times as small as that which corresponds to the luminosity of corresponding stars without mass loss. 2. The density distribution in the envelope of the star is more homogeneous as in normal stars with the same luminosity because of its expanded envelope. The stability coefficient is much larger than that expected from its luminosity. (auth)

36616 A SURVEY OF SOUTHERN Be STARS. II. PHOTOMETRIC DATA. Feinstein, Alejandro (Univ. Nacional de la Plata, Argentina). Z. Astrophys., 68: 29-47(1968).

Seventy two bright southern Be stars from the list of Paper I were observed photoelectrically in the UBV system over a three year time interval. Some of them were also observed in the RI system. It was found that 33 stars display variations in V larger than $0^m.06$ and that 21 change in U–B by more than $0^m.06$. The variations are either progressive or irregular, and changes up to $0^m.3$ have been observed. The variations in V, B–V and U–B show a certain degree of correlation. Combining two color diagrams it is concluded that Be stars display both an ultraviolet and an infrared excess. Comparison with other observers shows that despite the relative short time interval covered by the observations, the values found can be regarded as a representative sample. (auth)

36617 NEW MAGNETOGRAPH FOR SIMULTANEOUS MEASUREMENT OF LONGITUDINAL AND TRANSVERSE ZEEMAN EFFECT IN SOLAR SPECTRUM. Brueckner, G. (Univ. of Maryland, College Park). Z. Astrophys., 68: 48-84(1968). (In German).

The magnetograph is an extension of the Kiepenheuer–Babcock magnetograph for measuring simultaneously the longitudinal and the transverse Zeeman effect in the solar spectrum. The necessary optical and electronic modifications of the standard Babcock magnetograph are explained. Unno's theory of a normal Zeeman triplet in the solar atmosphere was used to transform the measured polarization values into field strength H and field angle ψ, (ψ referred to the line of sight). The values of H and ψ are ambiguous, if one integrates the Unno theory over an exit slit width comparable with the line width. In order to exclude these ambiguities a suitable method of reduction was developed. Two "vector magnetograms" of a quiet and an active spot group are given and their characteristic differences are discussed. The magnetic field distribution of the active group in which the large proton flare of July 7, 1966, happened is given in detail (λ = 5250 longitudinal and transverse fields, Hα longitudinal fields). The magnetograph also was used as a standard Babcock magnetograph to record weak longitudinal fields in different lines of the solar spectrum. One gets clearcut differences between photospheric and chromospheric field patterns. These differences are more important in active than in quiescent groups. (auth)

36618 ON FORBIDDEN LINES OF NEUTRAL SULPHUR IN THE FRAUNHOFER SPECTRUM. Swensson, J. W. (Univ., Lund, Sweden. Univ., Liege). Z. Astrophys., 68: 151-5(1968).

A search was made in the solar spectrum for the lines arising in transitions within the ground configuration, $3s^23p^4$, of neutral sulfur. Two weak Fraunhofer lines, at λ 10821.20 and λ 11304.99, were tentatively ascribed to the forbidden transitions $3p^4\ ^3P_2 - 3p^4\ ^1D_2$ and $3p^4\ ^3P_1 - 3p^4\ ^1D_2$, respectively, in S I. If the proposed identifications are correct, the relative weakness of the observed lines suggests that the photospheric sulphur abundance derived by Goldberg, Müller, and Aller is too high by a factor of about two. More precise laboratory data concerning the ground configuration of SI are clearly needed. (auth)

36619 ON AN ITERATIVE PROCEDURE FOR EVALUATING Z-VELOCITY DISPERSIONS FROM A GALACTIC MASS MODEL. Innanen, K. A.; Kellett, D. I. (York Univ., Toronto). Z. Astrophys., 68: 226-8(1968).

In order to examine dynamic nonequilibrium effects in the Galaxy, an iterative procedure for computing approximate velocity dispersions perpendicular to the galactic plane from a mass model is proposed and numerically treated. It is found that the results of Innanen and Fox, 1967, are still applicable for highly flattened Schmidt-type spheroids even for moderately strong nonequilibrium, whereas their results for less highly flattened (halo) spheroids apply only for strict or nearly strict equilibrium. (auth)

36620 GALACTIC STAR CLUSTER Tr. 15. Grubissich, C. (Univ., Basel). Z. Astrophys., 68: 173-5(1968). (In German).

U_cBV photometry of the cluster Tr. 15 on plates taken at the Royal Cape Observatory leads to a color excess of E(B–V) = $0^m.53$ and to a distance modulus of $(m-M)_0 = 11^m.14$ (1.7 kpc).(auth)

36621 EXPERIMENT ON THE DETERMINATION OF STAR DENSITY IN THE GALACTIC HALO WITH THE AID OF THREE-COLOR PHOTOMETRY. III. SELECTED AREA 54. Fenkart, Rolf P. (Univ., Basel). Z. Astrophys., 68: 87-97(1968). (In German).

Selected Area 54(b_{II} = +59°) lies between Selected Area 51(b_{II} = +21°, Becker, 1965) and Selected Area 57 (b_{II} = +85°, Fenkart, 1967). In this direction the populations were separated and the density-functions were determined for halo and disc in different luminosity intervals. The halo density has a more continuous and steeper gradient in SA 54 than in the other two fields, with higher values in the nearest volume. The density-functions extend up to 13 kpc. For the disc the density functions behave essentially like in SA 57. 33 galaxies and 9 white objects were identified. (auth)

36622 THREE-COLOR PHOTOMETRY OF SOUTHERN STAR CLUSTERS NGC 6242, NGC 6268, AND Tr 24. Seggewiss, Wilhelm (Univ., Bonn). Z. Astrophys., 68: 142-50(1968). (In German).

Observational material obtained at the Boyden Observatory in South Africa was used for a three color photometry of the open clusters NGC 6242, NGC 6268, and Tr 24. Distances and reddening of the clusters were determined analytically—contrary to the more common graphical method. The distances of NGC 6242 and NGC 6268 are 1215 pc and 1110 pc, the color excesses (E_{B-V}) 0^m39 and 0^m41, respectively. Tr 24 forms the northern part of the association Sco OB 1. Its unusually high linear diameter suggests the hypothesis that it may decay into smaller stellar condensations. Subgroups Tr 24 I, Tr 24 II, and Tr 24 III were investigated separately. Their distances are 1570 pc, 1630 pc, and 1590 pc and their color excesses (E_{B-V}) 0^m37, 0^m38, and 0^m39. The course of interstellar absorption with distance was determined from the reddening of field stars. The clusters are members of the inner spiral arm next to the Sun. (auth)

36623 PROPERTIES OF DIRECTED AND ISOTROPIC WAVES IN GRAVITATIONAL FIELDS. Dehnen, H. (Univ., Freiburg i. B.). Z. Astrophys., 68: 190-200(1968). (In German).

The properties of electromagnetic waves in gravitational fields, especially the behavior of frequency and energy density, are derived in the framework of Jordan's theory of gravitation. (auth)

36624 DOES THE 3°K RADIATION INFER A CONSTANT OR VARIABLE GRAVITATIONAL CONSTANT? Hoenl, H.; Dehnen, H. (Univ., Freiburg i. B.). Z. Astrophys., 68: 181-9(1968). (In German).

According to the results of several authors the cosmic microwave radiation of 3°K proves to be a real black-body radiation, i.e., without any dilution or concentration. The interpretation of this fact in the framework of Jordan's theory of gravitation is that the "gravitational constant" has remained unchanged during the cosmic evolution of the Universe. (auth)

36625 COMMENT ON THE WORK OF H. HOENL AND H. DEHNEN: DOES THE 3°K RADIATION INFER A CONSTANT OR VARIABLE GRAVITATIONAL CONSTANT? Jordan, P. Z. Astrophys., 68: 201-3(1968). (In German).

The valuable results of Hönl and Dehnen show that those field equations by which the author (1952) tried to formulate a relativistic theory of gravitation with a scalar κ field must be abandoned and replaced by other ones, published by the author elsewhere and repeated here. (auth)

36626 EFFECT OF FINITE LARMOR RADIUS ON THE GRAVITATIONAL INSTABILITY OF A PLASMA. Bhatia, P. K. (Univ. of Jodhpur, India). Z. Astrophys., 68: 204-7(1968).

The modified Chew–Goldberger–Low equation, which includes the effect of finite Larmor radius (F.L.R.) of the ion, was applied to the study of the problem of the gravitational instability of a plasma. The dispersion relation was obtained, because of mathematical simplicity, only for the case of wave propagation transverse to the magnetic field. It is found that the F.L.R. of ions has no influence on the Jeans instability. (auth)

36627 PLUTONIUM–XENON AND IODINE–XENON CHRONOLOGY OF THREE LIGHT–DARK-STRUCTURED CHONDRITES. Rao, M. N.; Meason, J. L.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Icarus, 8: 481-5(May 1968).

$^{244}Pu/^{136}Xe$ and $^{129}I/^{129}Xe$ decay intervals of the dark phases of three chondrites—Leighton, Fayetteville, and Pantar—were calculated and the results are discussed with reference to their origin from a material similar in composition to that of carbonaceous chondrites. (auth)

36628 EXPERIMENTAL OSCILLATOR STRENGTHS FOR THE O I LINES λλ1302 to 1306 and 1152 Å. Gaillard, Michel; Hesser, James E. (Princeton Univ. Observatory, N. J.). Astrophys. J., 152: 695-700(June 1968).

Radiative lifetimes were measured by the phase-shift technique for the two ultraviolet O I lines λλ1302 and 1152 Å. A substantial improvement over an earlier lifetime measurement by Savage and Lawrence, τ(1302 Å) = 2.4 nsec, was achieved through the use of H_2O instead of CO as a parent molecule for the electron-impact excitation of the oxygen lines, resulting in a reduction of an undesirable cascading process. The results were: $\tau(3s^3S^0)$ = 1.7 nsec and $\tau(3s'^1D^0)$ = 1.9 nsec. The oscillator strengths were compared with other values and were used to revise Stone and Morton's interstellar O, C, Si, and Al abundance ratios. (auth)

36629 EIGENFUNCTION DESCRIPTION OF RADIATIVE TRANSFER IN SCATTERING ATMOSPHERES. Pomraning, G. C. (Gulf General Atomic, Inc., San Diego, Calif.). Astrophys. J., 152: 809-21(June 1968).

Fraser (1966) has recently derived an equation of radiative transfer which describes the Compton scattering of photons from a Maxwellian gas of free electrons by a second-order differential operator. In this paper it is shown that Fraser's equation can be somewhat simplified without invoking any additional assumptions and that the resulting equation of transfer for a scattering atmosphere admits an eigenfunction expansion as a treatment of the frequency variable. The appropriate eigenvalue problem is studied, and the spectrum is found to consist of two discrete points and a continuum. The eigenfunctions corresponding to the discrete eigenvalues are elementary functions, and the continuum eigenfunctions are essentially confluent hypergeometric functions of the second kind. (auth)

36630 IONIZATION STRATIFICATION AND THERMAL STABILITY IN MODEL PLANETARY NEBULAE. Harrington, J. Patrick (Ohio State Univ., Columbus, Ohio Wesleyan Univ., Delaware). Astrophys. J., 152: 943-62(June 1968).

A number of model planetary nebulae were constructed with radii and densities chosen to fit the evolutionary sequence as determined by Seaton. The nebulae are idealized as homogeneous spherical shells of gas illuminated by central stars whose flux is represented by the model-atmosphere calculations of Böhm and Deinzer. The gas is considered composed of H, He, C, N, O, and Ne. The cooling of the gas by collisional excitation includes the fine-structure levels, and full account is taken of collisional deexcitation. The spherical radiative transfer problem for the diffuse radiation is solved by iteration. The thermal stability of the gas against the formation of condensations is tested at each point in the models. All were found to be thermally stable throughout. The electron temperature, ionization structure, and the integrated intensities of lines of H I, He I, He II, [N II], [O II], [O III], [Ne III], [Ne IV], and [Ne V] are presented for six models. (auth)

36631 MOVING PAIRS AMONG THE A-TYPE STARS WITHIN 20 pc. Vandervoort, Peter O. (Univ. of Chicago). Astrophys. J., 152: 895-904(June 1968).

Among the twenty A-type stars within a distance of 20 pc from the Sun there are several pairs and a triple composed in each case of stars having similar space motions. The probability of the occurrence of so many such moving systems in this sample is extremely small if it is a random sample drawn from a kinematically homogeneous group of stars among which the velocities are not correlated. For this reason, moving pairs are interpreted as pairs of stars which had common origins and now have similar orbits in the Galaxy. Moving pairs could be extreme examples of the phenomenon of moving groups, or they could be fine details in the phenomenon. The relative motion of a moving pair is sensitive to fluctuations in the prevailing gravitational field, and this fact is the basis for an estimate of the time of relaxation of the orbit of a star in the solar neighborhood. For the pairs in this sample it is found that the time of relaxation exceeds 1.4×10^{12} years. (auth)

36632 THE SPECTRA AND MASSES OF THE BLUE "HORIZONTAL-BRANCH" STARS IN M67. Sargent, Wallace L. W. (Mount Wilson Observatory, Pasadena, Calif. Palomar Observatory, Pasadena, Calif. Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 152: 885-93(June 1968).

Forty-eight Å mm^{-1} spectrograms together with photoelectric scanner observations of ten stars which form the blue end of a horizontal branch in the color–magnitude diagram of M67 were obtained. Attempts were made to determine effective temperatures and gravities for these stars by comparison of their hydrogen-line profiles and continuous energy distributions with model-atmosphere computations. Due to difficulties in subtracting out the effects of metallic-line blanketing, values of θ_e and log g were only obtained for the four bluest stars. Pesch has classified one of these as an Am star. Three of these stars, all having early A-type spectra, have low values of log g as compared with main-sequence stars. Their mean mass is calculated to be 0.7 ± 0.2 $M_\odot$. This is not considered to be significantly different from the mass of 1.09 $M_\odot$ at the main-sequence turnoff point. It is considered that these three stars do constitute the blue end of a thinly populated horizontal branch in M67, similar to those in globular cluster H–R diagrams. The remaining star, Fagerholm 81, is a B8 V star lying in the projected zero-age-main sequence

of the cluster. Its mass is derived to be $2.6 \pm 0.7\ M_{\odot}$, normal for its position in the H–R diagram and in agreement with an earlier estimate by Wallerstein. Radial-velocity measurements give some indication that this star is not a cluster member. The implications of these results are discussed for (a) an understanding of the color–magnitude diagrams of old clusters; (b) theories concerning the nature of metallic-line stars; and (c) Deutsch's ideas concerning stellar rotation on the lower main sequence. (auth)

36633 THE EFFECTIVE TEMPERATURES OF A AND B STARS. Wolff, Sidney C. (Univ. of California, Berkeley); Kuhi, Leonard V.; Hayes, D. Astrophys. J., 152: 871-84(June 1968).

Continuous energy distributions and Balmer discontinuities of A and B stars were measured with a spectrum scanner and reduced to absolute fluxes using the new calibration of Vega by Hayes. Fits to theoretical model fluxes now give good agreement between effective temperatures determined from the Balmer jump and from the continuum. The temperature scale so determined is also consistent with that derived from the interferometric measurements of stellar radii by Brown et al. The new scale used with blanketed model atmospheres also reduces the discrepancy between observed and predicted far-ultraviolet fluxes. (auth)

36634 SURFACE-GRAVITY DETERMINATIONS FOR MAIN-SEQUENCE B STARS. Strom, S. E.; Peterson, D. M. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 152: 859-69(June 1968).

Hydrogen-line equivalent widths computed from model atmospheres were used to obtain values of surface gravity for B stars by comparison with observed Hγ equivalent widths. The effects of stellar rotation and differing line-broadening theories on the deduced gravities are discussed. When the effects of rotation are allowed for and the Edmonds, Schlüter, and Wells semi-empirical Stark broadening theory is used, a mean surface gravity, $\log g = 4.25$, is found for B stars. This determination lies within 0.1 in the log of the values deduced from double-lined eclipsing-binary systems and computed interior models for B stars. (auth)

36635 THE EFFECTS OF AXIAL ROTATION ON THE EQUIVALENT WIDTHS OF SPECTRAL LINES. II. PURE ABSORPTION LINES. Collins II, George W. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J., 152: 847-58(June 1968).

The second paper in this series extends the previously developed theory describing the effects of rotation upon equivalent widths of spectral lines to those lines formed by a pure absorption mechanism. Using a Milne–Eddington type of atmosphere and a rigidly rotating Roche model, expressions are developed for the equivalent width of a line where the line absorption coefficient may be represented by a power law in the effective temperature. It is found that the behavior of absorption lines is both qualitatively and quantitatively different from earlier results for resonant scattering lines. It is unlikely that errors resulting from axial rotation in the spectral class of a star of more than one-tenth of a spectral class will arise. In addition, it appears unlikely that a star's luminosity class will be seriously affected by axial rotation. Finally, small errors in abundance determinations arising from a curve-of-growth analysis may result. (auth)

36636 MICROTURBULENCE IN GAMMA EQUULEI. Preston, George W.; Cathey, Larry R. (Lick Observatory, Mt. Hamilton, Calif. Univ. of California, Santa Cruz). Astrophys. J., 152: 1113-4(June 1968).

Because of a discrepancy in the value of the microturbulent velocity parameter of γ Equ, it was decided that a direct test should be made. To this end a 2.0 Å/mm spectrogram of γ Equ, well exposed in the region λλ 3400 to 3550, was obtained on Kodak-baked IIaO emulsion with the Coudé spectrograph of the 120-inch telescope. Some fifty unblended lines of neutral and ionized metals in this wavelength interval were identified on a direct-intensity microphotometer tracing. For each line, the central depth and the half-width at one-half central depth were measured. (W.D.M.)

36637 POSSIBLE HORIZONTAL-BRANCH STARS AT HIGH GALACTIC LATITUDES. II. Philip, A. G. Davis (State Univ. of New York, Albany. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 152: 1107-12(June 1968).

Recently (Philip, 1967a) ten stars were identified as possible horizontal-branch stars because of their similarity in four-color photometry to stars like HD 109995 and HD 86986 which have been classified as horizontal-branch field stars. At the present time, ten additional stars have been found which belong to this group. Positions and finding charts are given for the ten new stars along with the results of UBV and four-color photometry of those stars reported on earlier which have been observed two or three times. (W.D.M.)

36638 COLLISIONAL RELAXATION IN STELLAR SYSTEMS. Gilbert, Ira H. (Brandeis Univ., Waltham, Mass.). Astrophys. J., 152: 1043-56(June 1968).

The theory of collisional relaxation in stellar systems was investigated by expanding the dynamics in powers of 1/N, the inverse of the number of stars in the system, and retaining terms to first order. No assumptions of binary encounters or spatial homogeneity were made, and collective effects were fully accounted for. It was found that collisional effects divide into two distinct processes. The first process consists of the acceleration of each star by its associated polarization cloud. The second process consists of the acceleration of each star by a certain random, fluctuating, gravitational field. This field is a superposition of the "dressed" interparticle forces of each of the other stars, these stars being considered to be independently distributed and to move along unperturbed orbits. (auth)

36639 FURTHER OBSERVATIONS OF QUASI-STELLAR OBJECTS WITH ABSORPTION-LINE SPECTRA: TON 1530, PKS 0237–23, AND PHL 938. Burbidge, E. Margaret (Univ. of California, San Diego); Lynds, C. R.; Stockton, A. N. Astrophys. J., 152: 1077-93(June 1968).

Evidence is presented that quasi-stellar objects having large emission-line red shifts can have a multitude of absorption-line red shifts. (auth)

36640 CELESTIAL POSITIONS OF X-RAY SOURCES IN SAGITTARIUS. Bradt, H.; Naranan, S.; Rappaport, S.; Spada, G. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Astrophys. J., 152: 1005-13(June 1968). (MIT–2098-414).

During a sounding rocket flight on July 7, 1967, the celestial positions of six x-ray sources in the Sagittarius region were measured with a typical precision of 20′. One of these sources, at $b^{II} = +9°$, is reported here perhaps for the first time. An upper limit of 6×10^{-10} erg cm^{-2} sec^{-1} was obtained for x radiation (1.5 to 6 keV) from the Kepler supernova remnant SN 1604. (auth)

36641 AN OPTICAL SEARCH FOR X-RAY SOURCES IN SAGITTARIUS. Blanco, V. (Cerro Tololo Inter-American Observatory, Chile); Hiltner, W. A.; Lynga, G.; Bradt, H.; Clark, G.; Naranan, S.; Rappaport, S.; Spada, G. Contract AT(30-1)-2098. Astrophys. J., 152: 1015-17(June 1968). (MIT–2098-415).

An attempt was made to find optical counterparts for some x-ray sources in Sagittarius. An ultraviolet object ($V \approx 13.4$, $B - V = +1.0$, $U - B = -0.9$) was found at $\alpha(1950) = 17^{h}42^{m}7$, $\delta(1950) = -26°10'$, 10′ from the most probable position of GX3 + 1. (auth)

36642 BRIGHTNESS TEMPERATURE OF THE QUIET SUN AT CENTIMETER AND MILLIMETER WAVELENGTHS. Shimabukuro, F. I.; Stacey, J. M. (Aerospace Corp., El Segundo, Calif.). Astrophys. J., 152: 777-82(June 1968).

Brightness-temperature measurements of the quiet Sun are tabulated and plotted for the centimeter, millimeter, and infrared wavelengths. The plot gives an overall picture of the chromosphere. The measurements at centimeter and millimeter wavelengths are compared with temperatures derived from two solar models. The reported brightness-temperature measurements show that a revision of chromospheric electron temperature and density estimates is needed and suggest the possibility of a temperature inversion in the chromosphere. The refinement of chromospheric models is dependent upon more accurate and higher-resolution measurements at millimeter wavelengths. (auth)

36643 YTTRIUM ABUNDANCE IN THE SUN. Krueger, T. K. (Aerospace Research Labs., Wright-Patterson AFB, Ohio); Aller, L. H.; Ross, J.; Czyzak, S. J. Astrophys. J., 152: 765-75(June 1968).

Transition probabilities of permitted lines involving $5s^2$, 4d5s, $4d^2$, 4d5p, and 5s5p configurations of Y(II) were calculated using Hartree–Fock self-consistent field wave functions to obtain the dipole length. Intermediate coupling and configuration interaction were taken into account in the calculation of the line strength. The gf values were used to obtain the solar abundance of yttrium. A theoretical curve consisting of plot of $\log (W/\lambda)_{exact}$ versus $\log (W/\lambda)_{u}$ was made from which a final derived abundance turned out to be $\log N(Y)/\log N(H) = (1.43 \pm 0.35) - 12.00$. (Good agreement was obtained between theoretical and observed values.) (auth)

36644 THE EFFECT OF THE FORBIDDEN CONTINUUM OF H^- IN THE SOLAR ATMOSPHERE. Myerscough, Valerie P. (Univ. of California, Berkeley). Astrophys. J., 152: 1115-18 (June 1968).

Recently Holweger (1967) constructed an empirical model of the solar atmosphere under the assumption of LTE. On attempting to calculate the emergent continuous flux in the center of the Sun using this model, he found fairly strong deviations from observa-

tion in certain wavelength regions. The discrepancy in the uv can probably be understood as being due to the neglect of absorption lines in the computations. However, there is also a significant difference between the observed and calculated flux in the region shortward of λ 16,000 Å, in the sense that the theoretical results give too large a flux. The continuum in this region is formed in fairly deep layers; in this note a further process of continuous absorption that may reduce the theoretical emergent flux in the red is considered. (W.D.M.)

36645 OPTICAL AND RADIO EVIDENCE OF LARGE-SCALE PECULIAR MOTIONS IN THE CASSIOPEIA–PERSEUS ARM. Rickard, James J. (Univ. of Maryland, College Park). Astrophys. J., 152: 1019-42(June 1968).

Recent optical data on young open clusters, H(II) regions, O associations, interstellar extinction, and interstellar absorption lines together with new high-resolution 21-cm line hydrogen maps of the Cas–Per spiral arm ($97° < l < 150°$, $-1.0° \leq b \leq 1.0°$) indicate that the interstellar medium in a large section of the arm is moving with peculiar radial velocities of the order of −20 to −30 km sec^{-1}. A distance estimate based upon the interstellar absorption lines, interstellar extinction, and H(II) regions indicates that the gas, dust, and ionized elements are situated 1.5 to 2.5 kpc from the Sun. A new determination of Oort's constant A shows that the extremely young clusters with H(II) regions form a peculiarly moving kinematic group (group P), distinct from the normally moving O associations and other young clusters (group N). The age of the group P objects is about 6×10^6 years, while that of the group N objects is estimated to be 10 to 30×10^6 years. The mass and gas-to-dust ratio of the Cas–Per arm are also calculated. A model which explains the observed peculiar motions and the age differences is an expanding ring or shell in the galactic plane. This ring contains about 10^7 $M_\odot$ and is expanding at 20 to 30 km sec^{-1} from the direction $l = 120°$. It is approximately 1600 pc in diameter and is similar to rings which have been observed in the Magellanic Clouds. The ring is postulated to have been caused by one super-supernova, a small number of large supernovae, or a large number of ordinary supernovae. The explosion took place less than 30×10^6 years ago, and the object producing the ring must have been a group N member; the peculiarly moving group P objects are much younger and were formed from the expanding ring. The high- and intermediate-velocity hydrogen clouds reported by the Dutch are also included in the model. They indicate that the explosion took place slightly above the plane. (auth)

36646 THE DISTRIBUTION OF GALAXIES NEAR THE CENTER OF THE COMA CLUSTER. Rood, Herbert J.; Turnrose, Barry E. (Wesleyan Univ., Middletown, Conn.). Astrophys. J., 152: 1057-66(June 1968).

Statistical tests of distribution identity indicate that there are definite tendencies toward mass segregation in the extreme central portion of the Coma Cluster. The bright ($m_{pg} \leq 15.7$) galaxies are more centrally concentrated than the dwarf galaxies. The SB0's appear to be distributed about a different center than are the other galaxies. The ellipticals have a radial distribution statistically identical to that of the S0 galaxies. There are no significant differences in the angular distributions of any groups. Closeness of association and subclustering analyses imply that the dwarf galaxies are not satellites of more massive galaxies, and the only evidence of subgrouping of similar types of galaxies is the distribution of the SB0's. Quantitative estimates indicate that the anomalously large mass–light ratio for the cluster cannot be reduced significantly by considering subgrouping or mass-segregation effects. (auth)

36647 THE STRUCTURE OF THE IRREGULAR GALAXY NGC 4449. Hitchcock, John L.; Hodge, Paul W. (Univ. of California, Berkeley). Astrophys. J., 152: 1067-76(June 1968).

NGC 4449 is a typical Type I irregular galaxy, used by Hubble as a type example of its class. Photographs in V, B, and Hα, with photoelectric surface photometry, were used for the purpose of studying its structure and content. The distance to NGC 4449, determined from the diameters of the largest of the H(II) regions detected, is 3.3 ± 0.2 Mpc. Its mean dimension is 4.5 kpc, and its absolute magnitude is $M_V = -18.0$. Isophotes in two colors show the dominance of a large number of resolved features. Of these, at least eighty-one are H(II) regions, and the remainder are globular clusters, associations, and bright stars ($M_v \approx -7$). Resolved features are virtually absent from one quadrant. In an attempt to determine the underlying structure of the galaxy, a set of isophotes were plotted from tracings from which the resolved features that stand alone were removed. The result shows that the older star population is arranged roughly rectangularly, with one corner anomalously rounded. (auth)

36648 GALACTIC ROTATION CURVE. Bash, Frank N. (Univ. of Texas, Austin). Astrophys. J., 152: 1095-1100(June 1968).

The method by which the galactic rotation curve has been obtained, using 21-cm radiation, is examined. If the assumption of low optical depth is abandoned, certain apparent line-profile anomalies in previous determinations of the galactic rotation curve can be explained. If the larger optical depths suggested in this paper are correct, then the present galactic rotation curve is too high by about 10 km sec^{-1}, and also deviates systematically from the true one as a function of galactic longitude. In addition, the values of T, the excitation temperature, and σ, the dispersion of random motion, are found to be quite variable from one tangent point to another. (auth)

36649 COMPACT GALAXY (III Zw 2) AND A COMPACT RADIO GALAXY (3C 120) WITH SEYFERT-TYPE SPECTRA. Arp, Halton (Mount Wilson Observatory, Pasadena, Calif. Palomar Observatory, Pasadena, Calif. Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 152: 1101-6(June 1968).

Two compact galaxies with Seyfert-like spectra were analyzed. One is a radio galaxy that has radio characteristics which resemble a quasi-stellar object. Photoelectric photometry shows this galaxy (essentially the sharp nucleus) to have U−B, B−V colors like a QSS. The other compact has an extremely high redshift for its apparent magnitude and colors that also resemble a quasi-stellar source. The two compact galaxies are compared to Seyfert galaxies and QSS's with respect to the width of their hydrogen emission lines. It is shown that both compacts fall intermediate in the redshift–apparent-magnitude diagram between quasi-stellar objects and normal Seyfert galaxies. (auth)

36650 INTERNAL MOTIONS IN THE ORION ASSOCIATION. I. THE SUBGROUP Ia ORI. Lesh, Janet Rountree (Yerkes Observatory, Williams Bay, Wis. Univ. of Chicago). Astrophys. J., 152: 905-11(June 1968).

The Northwest region of the Orion association is found to have a significantly smaller distance modulus than the Belt and Sword regions and to be in a more advanced evolutionary state. Analysis of the proper motions in this region leads to a rate of expansion of 0.00081″ deg^{-1} year^{-1}, corresponding to a kinematic age of 4.5×10^6 years. (auth)

36651 INTERSTELLAR EXTINCTION IN THE ORION ASSOCIATION. Lee, Thomas A. (Univ. of Arizona, Tucson). Astrophys. J., 152: 913-41(June 1968).

Photoelectric photometry of 196 members of I Orionis was obtained in an effort to determine the wavelength dependence of interstellar extinction throughout the association. Regional extinction laws were calculated from the color excesses of individual stars in localized areas. Equivalent monochromatic laws were also computed. Two areas of the association, the center of the Orion Nebula and the east "Belt" region near ζ Orionis, exhibit significantly "non-normal" extinction. The anomalies in both cases are a steep infrared extinction gradient and a high ratio of total to selective absorption. In the east Belt region, $R \simeq 5.5$, whereas near θ^1 Orionis, $R \geq 5.5$. The anomaly in the Orion Nebula is confined to the center of the nebula, within 15′ of θ^1 Orionis. Efforts to explain the strong infrared radiation of the early-type stars in this region in terms other than interstellar extinction have been unsuccessful; circumstellar emission is possible, but cannot account for the entire effect. In all cases, the stars in I Orionis showing decidedly non-normal extinction laws are closely associated with bright nebulosity and are of the earliest spectral types. Yet similar-type stars in the same region often exhibit no such anomalies. The data give additional credence to the suggestion that the obscuring matter is modified by hot, young stars; in fact, several of the Orion extinction laws closely resemble those resulting from bimodal distributions of particles of different characteristic sizes. (auth)

36652 EFFECT OF DIFFUSE IONIZING RADIATION IN COLLISIONALLY EXCITED NEBULAE. Van Blerkom, David (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. J., 152: 963-70(June 1968).

The influence of "diffuse" ionizing radiation on the atomic-level populations of hydrogen was determined for nebulae in which collisions between free electrons and atoms are the primary source of excitation and ionization. For nebulae optically thick in the Lyman continuum, the effect of the diffuse radiation field is significant. The coresponding effect on the Balmer decrement is not as great and cannot explain the radiative value of the decrement observed in the Cygnus Loop. A model hydrogen atom consisting of fifty discrete levels is employed and the contribution of higher levels approximated. The transfer problem for the diffuse radiation is simplified by the use of the on-the-spot approximation. (auth)

36653 HEATING OF H I REGIONS BY ENERGETIC PARTICLES. Spitzer, Lyman Jr.; Tomasko, Martin G. (Princeton

Univ. Observatory, N. J.). Astrophys. J., 152: 971-86(June 1968).

The heating of interstellar H(I) regions by energetic particles, originally analyzed by Hayakawa, Nishimura, and Takayanagi, was reconsidered. A fourfold increase in the relative abundance of carbon and inclusion of C^+ and O excitation by H atoms increases the loss rate per cubic centimeter by more than an order of magnitude, decreasing the temperatures appreciably. Consideration of the ionization and excitation produced by the secondary electrons which result from ionizing collisions of energetic particles with H atoms indicates that 3.4 eV of kinetic energy are available for heating the gas for each hydrogen atom ionized. Temperature and ionization levels are computed for various values of ζ_f, the rate coefficient for ionization of H by energetic particles, including ionization produced by the secondaries. The minimum value of ζ_f consistent with the cosmic radiation observed at the Earth is 6.8×10^{-18} sec^{-1}; the corresponding equilibrium temperatures are less than 25°K for n_H for greater than 0.1 cm^{-3}, much less than the observed temperatures. A much higher value of ζ_f is obtained if the atoms in Type I supernova shells, which have an energy of 2 MeV per nucleon at a velocity of 20,000 km sec^{-1}, are assumed to permeate the Galaxy; the range of such protons in the galactic plane is about 700 pc. If at most one-third the shell energy of 10^{51} ergs is available in this form, a galactic frequency of one Type I supernova per 100 years gives an upper limit for ζ_f equal to 1.2×10^{-15} sec^{-1}; the computed temperatures range between about 30 and 120°K as n_H decreases from 10 to 0.1 cm^{-3}. These theoretical results are somewhat uncertain, but an increase of temperature with decreasing density seems consistent with the 21-cm data. The computed mean electron density in H(I) regions corresponding to the higher value for ζ_f is about 0.01 cm^{-3}. Deviations from equipartition are generally small, since collisions between electrons and positive ions and between positive ions and H atoms couple closely the kinetic temperature of all these components. (auth)

36654 THE MICROWAVE EMISSION OF SATURN. Berge, G. L.; Read, R. B. (Owens Valley Radio Observatory, Pasadena, Calif.). Astrophys. J., 152: 755-64(June 1968).

In order to identify the source(s) of microwave radiation from Saturn, long-base-line measurements were made with the two-element interferometer at the Owens Valley Observatory near the oppositions of 1965 and 1966. At least 90% of the 10-cm radiation comes from the visible disk. If there is a radiation belt, it supplies less than 10% of the 10-cm radiation. An upper limit of 0.08 can be fixed on the 10-cm optical thickness of the rings. The disk temperatures determined were 172 ± 20°K at 10.7 cm in 1965 and 165° ± 25°K at 9.0 cm in 1966. (auth)

36655 THE ECLIPSING BINARY SYSTEM SW LYNCIS. Vetesnik, M. (Purkyne Univ., Brno). Bull. Astron. Inst. Czech., 19: 110-22(1968).

Two-color light curves based on photoelectric measurements were determined for the system SW Lyncis. The period is discussed and a provisional solution of the elements based on an annular primary eclipse is given. (auth)

36656 CONTRACTING AND RADIATING BODIES. Demianski, M.; Lasota, J. P. (Univ. of Warsaw). Astrophys. Lett., 1: 205-7(July 1968).

A simple model of a contracting and radiating body, based on a suggestion by Bondi, is presented. The general properties and special solutions are discussed. During the collapse, the body contracts to zero volume, radiating away all its mass. (auth)

36657 ON POSSIBLE NON-RADIAL PULSATIONS OF BAKER'S ONE-ZONE MODEL. Zahn, J. P. (Observatoire, Nice). Astrophys. Lett., 1: 209-12(July 1968).

Using the boundary conditions derived by Okamoto and Unno, the vibrational stability of Baker's one-zone pulsation model undergoing nonradial oscillations was examined. In particular, it is shown that the stability of the radial pulsations does not necessarily imply the stability of all the nonradial modes. If they exist, stars which pulsate nonradially with the κ mechanism should be located in the region of the Hertzsprung–Russel diagram in which the δ Scuti variables are found. (auth)

36658 THE OBSERVED EFFECTS OF AXIAL ROTATION ON THE PULSATION OF DELTA SCUTI VARIABLES. Dickens, R. J. (Royal Greenwich Observatory, Sussex, Eng.). Astrophys. Lett., 1: 213-17(July 1968).

A number of correlations between observed properties of δ Sct variables are discussed. These variables provide evidence that pulsational instability can occur on the main sequence at effective temperatures around 7500°K and hotter. Axial rotation appears to limit the amplitude of pulsation and is also probably connected with the type of multiple periodicity found in these stars. (auth)

36659 ELECTRON TEMPERATURES OF GASEOUS NEBULAE FROM CONTINUUM TO LINE RATIOS. Lee, P. D. (Univ. of Illinois Observatory, Urbana). Astrophys. Lett., 1: 225-6(July 1968).

The electron temperatures for six planetary nebulae and the Orion Nebulae were determined from the ratio of the energy in the first 10 Å of the Balmer free-bound continuum to the energy in Hβ. (auth)

36660 ELECTRON TEMPERATURES OF GASEOUS NEBULAE FROM BALMER DECREMENTS. Kaler, J. B. (Univ. of Illinois Observatory, Urbana). Astrophys. Lett., 1: 227-30(July 1968).

Electron temperatures were measured for several planetary nebulae and the Orion Nebula by using the Balmer decrement between n = 9 and n = 30. The temperatures so derived are lower than those measured by the forbidden lines and are similar to the temperatures recently derived from the Balmer continuum and radio frequency observations. In many cases, the electron temperatures are the lowest yet measured, implying that unexplained anomalies still exist in the Balmer decrements. (auth)

36661 THE SPECTRUM OF ACCELERATED PARTICLES IN STARS, FROM LITHIUM AND BERYLLIUM OBSERVATIONS. Reeves, H.; Audouze, J. (Service d'Electronique Physique, Saclay, France. Institut d'Astrophysique, Paris). Astrophys. Lett., 1: 197-203(July 1968).

Recent determinations of ^6Li, ^7Li, and ^9Be abundances in main-sequence stars, together with recent determinations of nuclear formation and destruction cross sections of these elements are used to obtain some information on the mean spectrum of accelerated particles in stars. A spectrum of the form $\phi(E)dE \propto E^{-\gamma}dE$; with $\gamma = 2.5$ to 3 appears to meet the various requirements discussed in this paper. (auth)

36662 A NEW HOT, RAPID, VARIABLE STAR. Stephenson, C. B. (Case Western Reserve Univ., Cleveland); Sanduleak, N.; Schild, R. E. Astrophys. Lett., 1: 247-8(July 1968).

The star HDE 310376 was observed on an objective prism plate to have a spectrum similar to that of Sco X-1. Subsequent photoelectric photometry and slit spectroscopy show that, optically, the star does resemble Sco X-1. As far as the authors are aware, the object is not a known x-ray source. (auth)

36663 CLOSE BINARY LIGHT CURVE RECTIFICATION. Horak, T. (Military Academy, Brno). Bull. Astron. Inst. Czech., 19: 149-52(1968).

A rectification procedure for determining the elements of a distorted eclipsing binary is presented. It is suitable for calculations on an electronic computer by means of the iterative minimization method. As an example, the elements of V 505 Sgr (blue) were computed from both minima under the sphere-ellipsoid assumption. (auth)

36664 THE ECLIPSING BINARY SYSTEM V 338 HERCULIS. Vetesnik, M. (Purkyne Univ., Brno). Bull. Astron. Inst. Czech., 19: 135-48(1968).

Two-color light curves based on photoelectric measurements were determined for the system V 338 Herculis. The period is discussed and a provisional solution of the elements based on a partial primary eclipse (transit) is given. (auth)

36665 THE ECLIPSING BINARY SYSTEM V 463 CYGNI. Vetesnik, M. (Purkyne Univ., Brno). Bull. Astron. Inst. Czech., 19: 123-35(1968).

Two-color light curves based on photoelectric measurements were determined for the system V 463 Cygni. The period is discussed and a provisional solution of the elements based on an annular eclipse is given. The solution as well as the changes of the period indicate the presence of a third uneclipsed body in the system. (auth)

36666 THE RADIO SOURCE VRO 42.22.01. MacLeod, J. M.; Andrew, B. H. (National Research Council, Ottawa). Astrophys. Lett., 1: 243-6(July 1968).

Centimeter wavelength observations of VRO 42.22.01 at the Algonquin Radio Observatory have revealed that this source has an unusual spectrum. Its flux density increases by more than a factor of four between meter and centimeter wavelengths. Polarization was measured at two wavelengths, and an optical identification was made. (auth)

36667 INTERPLANETARY SECTOR STRUCTURE AND SOLAR RADIO EMISSION. Krueger, A. (Inst. of Solar-Terrestrial Physics, Berlin); Bumba, V.; Howard, R.; Kleczek, J. Bull. Astron. Inst. Czech., 19: 180-1(1968).

The relationship between the spectra of the slowly varying component, ranging from 1,000 to 10,000 MHz, and the magnetic fields in the photosphere was examined for the period 1963 through 1966. It was expected that long-lived features in the radio data might correspond to long-lived large-scale features on the synoptic charts. No connection was found between the large-scale weak solar magnetic field structures and the long-period characteristics of the radio emission. (W.D.M.)

36668 MAGNETIC FIELD RE-CONNECTION AT TANGENTIAL DISCONTINUITIES IN THE SOLAR WIND. Mihalov, J. D.; Sonett, C. P.; Colburn, D. S. (Ames Research Center, Moffett Field, Calif.). Astrophys. Lett., 1: 219-24(July 1968).

Data taken with the Mariner 2 spacecraft during a magnetic storm on October 7, 1962 show that maxima in the proton temperatures in the solar wind occurred in the same place as abrupt changes in the magnitude and direction of the magnetic field. The magnetic changes are identified as tangential discontinuities. Magnetic field reconnection cannot be excluded as the energy source for the temperature maxima, but the evidence for magnetic field reconnection is inconclusive. (auth)

36669 FORMATION OF GALAXIES BY FRAGMENTATION. Sersic, J. L. (Observatorio Astronomico, Cordoba, Argentina). Bull. Astron. Inst. Czech., 19: 105-10(1968).

Observational evidence for the existence of two kinds of elliptical galaxies is discussed. The distribution of galaxies in the mass–radius diagram is interpreted as the result of fragmentation of elliptical galaxies of large mass. A model describing the gross properties of galaxies resulting from explosive events is developed and shown to be in fairly good agreement with observations. The properties of unstable groups of galaxies and clusters are also discussed. (auth)

36670 SPACED-SPECTROGRAPH OBSERVATIONS OF JUPITER'S DECAMETRIC EMISSION. Riihimaa, J. J. (Univ. of Florida, Gainesville). Astrophys. Lett., 1: 231-41(July 1968).

The right-hand circular component of Jupiter's decametric radio bursts was observed with two identical high-resolution radio spectrographs, spaced by 70 km. The results indicate that the complicated structures in the dynamic spectra originate outside the terrestrial ionosphere, while the ionosphere induces only a slow scintillation component with periods of approximately 1 min and longer. (auth)

36671 EVOLUTION OF MASSIVE STARS DURING THE EARLY MAIN-SEQUENCE PHASE. Uchida, Juichi; Suda, Kazuo; Hitotuyanagi, Zyuiti (North Japan Coll., Tohokugakuin-Daigaku). Sci. Rep. Tohoku Univ., First Ser., 50: 8-16(Feb. 1967).

The argument of Sakashita and Hayashi (Prog. Theor. Phys., 22: 830(1959)) on the structure of massive stars with a convective core is reconsidered. The models consist of a radiative envelope and a convective zone with inhomogeneous abundance distribution. The convective zone is assumed to consist of an outer zone approximately in convective neutrality, an inner chemically homogeneous core, and an intermediate transition zone where the gradient of abundance distribution is given by a function with three parameters varying continuously from the outer zone to the inner core. Models with various abundance distributions are constructed for a specified stage of evolution. It is found that, except for the abundance distribution, physical characteristics of the possible models can be approximated by those of Sakashita and Hayashi's model. This result is reinforced by a simple consideration of convective mixing which leads to the conclusion that the intermediate transition zone must be very narrow. (BBB)

36672 DYNAMICAL EVOLUTION OF TRIPLE STARS. Harrington, Robert S. (Naval Observatory, Washington, D. C.). Astron. J., 73: 190-4(Apr. 1968).

The solution of the stellar 3-body problem by the von Zeipel method produced 2 additional integrals of motion and showed that the semimajor axes have no secular terms, meaning triple stars are dynamically stable. The solution of the long-period problem, using the Weierstrass elliptic function, revealed a quasi instability in systems with approximately perpendicular orbits, due to the finite size of the stellar components. Usually the eccentricity of the outer orbit is constant through the third order in the Hamiltonian, but the eccentricity of the inner orbit and the mutual inclination show large periodic variations, the statistical effect of which is to produce an increase in the number of such systems with low mutual inclinations and high-eccentricity inner orbits. (BBB)

36673 COEFFICIENT OF LIMB-DARKENING FOR DWARFS. Hosokawa, Yoshimasa (Yamagata Univ., Japan). Sci. Rep. Tohoku Univ., First Ser., 50: 1-7(Feb. 1967).

Limb-darkening, a phenomenon observed in the Sun and eclipsing binaries, depends on the structure of the stellar atmosphere. Recently constructed model stellar atmospheres based on a table of a monochromatic coefficient of limb-darkening required for the light curve analysis of eclipsing systems are given for dwarfs ranging from class F0 to class B0. Comparison of the tabulation with previous ones reveals that main sequence stars earlier than B8 increase considerably in limb-darkening, whereas for the later classes there generally is no change. Observational determinations of limb-darkening are reliable as a rule only when the light curve arises from an annular eclipse of components of unequal size or from nearly central eclipses mutually undergone by approximately equal components. For stars later than B9, the discrepancies between observation and theory in the new comparison are reduced to the same extent as in the old. Among the ill-behaved systems, three systems are: A0 Cassiopeiae of class 0, and SZ Camelopardalis ($\tau_1 = 0.425$, $\tau_2 = 0.188$) and VV Orionis ($\tau_1 = 0.389$, $\tau_2 = 0.188$) both belonging to Type I. In the last two systems, the components are rather too close to each other to permit accurate determination of limb-darkening. (BBB)

36674 ^{3}He IN SEVERAL MAGNETIC STARS. Zirin, Harold (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 152: L177-8(June 1968).

The presence of ^{3}He in 3 Cen A, ϵ-UMa, and γ^1 Vir is indicated by the shift in wavelength of the line He I λ10830. In several stars no λ10830 is observed. (auth)

36675 SPECTRUM OF THE CENTRAL STAR IN NGC 5189. Blanco, V. (Cerro Tololo Inter-American Observatory, Chile); Kunkel, W.; Hiltner, W. A.; Chodil, G.; Mark, Hans; Rodrigues, R.; Seward, F.; Swift, C. D. Astrophys. J., 152: L135-6(June 1968).

The spectrum of the central star in NGC 5189 shows strong, broad emission of O VI $\lambda\lambda$3811 and 3834 and less broad He II λ4686 emission. Variability of the star is briefly discussed. (auth)

36676 QUASI-STELLAR OBJECTS. Hoyle, F. (Cambridge Univ., Eng.). Proc. Roy. Inst. Gt. Brit., 41: 259-67(1967).

The quasi-stellar objects were discovered in 1963. Significant clues already available for several years before the actual discovery itself are discussed. Four observational tests, any one of which would have served to prove that quasi-stellar objects (QSOs) are cosmologically distant are developed: association with clusters; the appropriate relation between M_v and z; the appropriate relation between radio flux and z; blotting out of the continuum shortward of Lyman α. While the fact that none of the tests has yielded a positive result does not disprove the cosmological postulate, the consistent failure of the theory to establish itself must raise doubts. The observations also indicate the concept of large masses concentrated in small volumes, a condition favorable to the rival gravitational hypothesis. The particular redshift value of Z = 1.95 may have a special significance for the whole class of QSOs. Technical spectroscopic evidence suggests that this redshift is intrinsic to the QSOs and is not an effect arising from intergalactic gas. Thus the quasi-stellar objects appear to consist of very large masses, probably of galactic order, concentrated in small volumes. It is not yet known whether the redshifts of their spectrum lines arise from the expansion of the Universe or from strong gravitational fields. Tests that might have established the former hypothesis have failed to do so, and the trend of the evidence over the past two years has been in favor of the gravitational hypothesis. (BBB)

36677 GALACTIC X-RAYS: VARIABLE SOURCES IN HYDROMAGNETIC WAVES. LeLevier, R. E. (Rand Corp., Santa Monica, Calif.); Libby, L. Marshall. Science, 160: 1447-9 (June 28, 1968).

Galactic sources of x rays fluctuating in intensity are explained as being small regions, of enhanced gas density and temperature, emitting thermal Coulomb bremsstrahlung of keV energies. Hydromagnetic wave motions, of the magnetic fields in the galactic spiral arms, produce the enhanced regions by compressing the clouds of ionized gas to which they are tied by their high electrical conductivity. From the observed periods of fluctuation of a few months, together with the hydromagnetic velocity, it is estimated that the average size of sources does not exceed 10^{16} cm. By using the formula for Coulomb bremsstrahlung and requiring that the sources shall produce the observed x-ray fluxes, one finds a second estimate of size of sources in agreement at about 10^{16} cm. Such regions are too small to be observable radio sources with current radio telescopes. (auth)

36678 NATURE OF PULSATING RADIO SOURCES. Woltjer, L. (Columbia Univ., New York). Astrophys. J., 152: L179-80(June 1968).

A very brief discussion is given on the nature of pulsars. The galactic distribution and pulsating mechanisms were considered. (W.D.M.)

36679 SURVEY OF RADIO SOURCES OBSERVED IN THE CONTINUUM NEAR 1420 MHz, DECLINATIONS -5° TO +70°. Galt, J. A.; Kennedy, J. E. D. (Dominion Radio Astrophysical Observatory, Penticton, Can.). Astron. J., 73: 135-51(Apr. 1968).

A survey of the continuum radiation near 1420 MHz was made using a 25.6-m parabolic antenna. Drift scans were obtained every quarter degree or every half beam-width between declinations −5° and +70°. The survey was undertaken to search for new radio sources that had not been found in previous lower-frequency surveys and to provide spectral data on those sources already known. Many of the sources were also observed at 3200 MHz; a few of these appeared to have spectra rising rapidly at high frequencies. A catalogue of 615 radio sources is presented. The survey is believed complete to a flux level of 2×10^{-26} W m^{-2}Hz^{-1}. The slope of the log N/log S plot for sources away from the galactic plane is -1.88 ± 0.07. There was no evidence for a change of slope with frequency. A study was made of the distribution of spectral indices for those sources which are common to the present survey and the 4C catalogue. For sources selected at 1420 MHz there was no change in median spectral index with flux density. (BBB)

36680 EVIDENCE FOR RELATIVISTIC EXPANSION IN VARIABLE RADIO SOURCES. Rees, M. J.; Simon, M. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 152: L145-8(June 1968).

Although observations suggest that the radio variations in extragalactic sources arise from an expanding component emitting synchrotron radiation, such a model is untenable unless the expansion velocities are ~c. A relativistically expanding model would be compatible with all the data, and long-base-line interferometers should soon provide a further test. The occurrence of relativistic expansion would reduce the estimated severity of inverse Compton losses in optically variable sources. (auth)

36681 CAN THE SIZE OF DISTANT SOURCES BE INFERRED FROM LUMINOSITY CHANGES? Morrison, P.; Sartori, L. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 152: L139-43(June 1968).

It is often argued that a distant radiation source must contain emitting regions no larger in diameter than $c\tau$, where τ measures the time scale of important variations in luminosity. That requirement is in fact imposed not on the emitting region itself but only on the primary source of its energy. If the observed radiation is secondary to a fast exciting pulse, the limit is very much relaxed. The optical changes in size (2″ per year) observed in 3C 287, for example, would, if confirmed, allow a distance ~10^7 to 10^8 lt-yr, much larger than the value of 10^5 lt-yr which follows from setting the apparent transverse velocity equal to c. More generally, the radio and optical observations on the time variations and the angularly unresolved components of quasi-stellar objects (e.g., 3C 273B) are shown to be consistent with emitting diameters as large as a thousand light years, taking the objects at their indicated cosmological distances. (auth)

36682 OPTICAL IMAGE OF 3C 287. Kristian, Jerome; Peach, John V. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 152: L161-3 (June 1968).

Several 200-inch and 48-inch Schmidt plates were used to investigate possible structure associated with the optical image of 3C 287, as reported by Matthews. No such structure was detected on plates taken in 1950, 1964, 1967, and 1968. Photographic, instrumental, and seeing effects on the appearance of the images are discussed, and it is suggested that Matthews' results may plausibly be ascribed to these. (auth)

36683 SPECTRUM OF AN ULTRAVIOLET OBJECT IN SAGITTARIUS. Blanco, V. (Cerro Tololo Inter-American Observatory, Chile); Kunkel, W.; Hiltner, W. A. Astrophys. J., 152: L137(June 1968).

The spectrum of the ultraviolet object near the X-ray source GX3 + 1 shows broad emission of He II λλ4686 and O VI λλ3811 and 3834. (auth)

36684 POPULATION OF HIGH ATOMIC LEVELS IN THE SOLAR CORONA. Dupree, A. K. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 152: L125-8(June 1968).

Significant departures from thermodynamic equilibrium are found for the populations of high levels of coronal ions. These overpopulations can lead to observable effects on the solar emission spectrum. The possibility of observing recombination lines in the micron and millimeter wavelength regions is discussed. (auth)

36685 REPEATED OUTBURSTS IN THE RADIO GALAXY 3C 120. Pauliny-Toth, I. I. K.; Kellermann, K. I. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 152: L169-75(June 1968).

The observed radio variations of 3C 120 are compared with those predicted from the model of a homogeneous cloud of relativistic electrons and magnetic field expanding at a constant rate. Excellent agreement is found, and an index $\gamma = 1$ is deduced for the electron energy distribution. An upper limit to the angular size of the variable component gives upper limits of 0.6c on the velocity of expansion and of 0.01 gauss on the magnetic field, when the apparent age is 0.7 year. (auth)

36686 NON-THERMAL COMPONENT IN THE CONTINUUM OF NGC 1068. Visvanathan, N.; Oke, J. B. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 152: L165-8(June 1968).

The polarization of NGC 1068 is high in the ultraviolet and gradually decreases toward longer wavelengths. With the help of the scanner data, the continuum of NGC 1068 is separated into thermal and nonthermal components by assuming that the nonthermal component has no wavelength dependence of polarization and that the observed change in percentage polarization with λ is due to the addition of unpolarized galaxy radiation. The derived nonthermal component is smooth and similar to the energy distribution of the quasi-stellar radio source 3C 273. (auth)

36687 POLYCYCLIC HYDROCARBONS, PLATT PARTICLES, AND INTERSTELLAR EXTINCTION. Donn, Bertram (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 152: L129-33(June 1968).

The measured absorption spectra of aromatic molecules can now be used to extend Platt's hypothesis by synthesizing extinction curves for selected molecular distributions. These distributions can be varied for the best match to the observed interstellar extinction as in the procedure used with Mie particles. Preliminary attempts have been carried out and satisfactory agreement attained in the visible region after smoothing the final summed laboratory curves. Polarization and magnetic properties of aromatic molecules suggest that interstellar polarization can be accounted for, although an analysis must still be made. (W.D.M.)

36688 RADIO OBSERVATIONS OF THE COMA CLUSTER OF GALAXIES. Bozyan, E. P. (Wesleyan Univ., Middletown, Conn.). Astrophys. J., 152: L155-9(June 1968).

Observations at 430 and 610.5 MHz of the Coma Cluster of galaxies show that Coma C has a spectral index of −1.6. Near the radio position of one of the components of Coma C is a faint blue object. (auth)

36689 NEW DETERMINATION OF THE HUBBLE CONSTANT FROM GLOBULAR CLUSTERS IN M87. Sandage, Allan (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 152: L149-54(June 1968).

An apparent blue distance modulus of $(m - M)_{AB} = 31.1$ is derived for the Virgo Cluster from Racine's measurement of B (first) = 21.3 for the brightest globular cluster in M87, using a calibration of M_B(first) = −9.83 for cluster B282 in M31. This assumes that the brightness globular clusters in the two galaxies have the same absolute magnitude. The assumption provides an upper limit to H in the present context. For this distance modulus, the absolute luminosity of NGC 4472—the first-ranked E galaxy in the Virgo Cluster—is $M_B = -21.68$. A new redshift−apparent magnitude relation (the Hubble diagram) for the first-ranked cluster members shows that M_B(first) has a remarkably small dispersion of ±0.3 mag in a sample of forty-one clusters. Using M_B from NGC 4472 and reading the Hubble diagram at $cz = 10^4$ sec^{-1}, which is beyond the local anisotropy in the velocity field, it is found that $H = 75.3^{+}_{-}$ km sec^{-1} Mpc^{-1}, using the precepts in the text. Systematic errors are discussed. It seems possible that H could be as small as 50 km sec^{-1} Mpc^{-1} ($H^{-1} = 19 \times 10^9$ years) with the present data. The local anisotropy in the velocity field at the Virgo Cluster is estimated to be $H_{\infty}/H_{VC} = 1.17 \pm 0.09$. (auth)

36690 EFFECT OF ENERGY CHANGES ON SOLAR COSMIC RAYS. Fisk, L. A.; Axford, W. I. (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 73: 4396-9(July 1, 1968).

A solution of the time-dependent, spherically symmetric Zokker–Planck equation is presented, in which nonrelativistic particles having a power low spectrum in kinetic energy are injected impulsively from a small spherical surface surrounding the origin. On the basis of this solution it is concluded that in solar cosmic-ray events convection by the solar wind and energy changes are likely to have significant effects, especially on the rate of decay of the intensity with time. (W.D.M.)

36691 SOLAR-WIND FLOW BEHIND THE MOON. Wolf, R. A. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 4281-9(July 1, 1968).

A simple fluid-flow calculation is used to describe the flow of the solar wind behind the Moon for the case where the magnetic field is parallel to the flow. The analysis extends the more qualitative discussions given by Michel and by Johnson and Midgley. Flow past the Moon is represented approximately by the simple-wave solution to the analogous two-dimensional problem. Theoretical pressure and magnetic-field profiles are given, describing the regions of rarefaction and recompression that surround the plasma-free void behind the Moon. The results are generally consistent with the work of Michel and of Johnson and Midgley. The present analysis does, however, indicate one new qualitative feature: the recompression is found to be most severe near the boundary of the rarefaction region. An outer shock wave forms on this boundary, about 5 lunar radii behind the Moon and about 1.4 lunar radii from the centerline (for average solar-wind parameters). A qualitative discussion is presented to show that the addition of a small magnetic-field component perpendicular to the flow causes the outer shock to weaken and move away from the Moon; a second, inner shock wave forms in the shadow of the Moon. (auth)

36692 MECHANISM FOR ACCELERATION OF ELECTRONS TO RELATIVISTIC ENERGIES. Michel, F. C. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 4135-8(July 1, 1968).

It is shown that energy in the form of magnetic field can be converted with essentially 100% efficiency into synchrotron radiation and cosmic rays under conditions expected to be present in astrophysical objects such as the Crab Nebula. The radiation reaction from synchrotron radiation provides an effective resistance that allows merging of magnetic field lines. The induction electric field generated by this merging accelerates the electrons to restore the energy lost as radiation. In astrophysical applications this mechanism can maintain the relativistic electron energies. (auth)

36693 INTERRELATIONSHIP OF COSMIC-RAY ANISOTROPIES AND THE INTERPLANETARY MAGNETIC FIELD. McCracken, K. C. (Univ. of Adelaide); Rao, U. R.; Ness, N. F. J. Geophys. Res., 73: 4159-66(July 1, 1968).

The direction of the cosmic-ray anisotropy during solar proton events and the concurrent direction of the interplanetary magnetic field vector are compared, using data obtained in 1966 by the Pioneer 6 spacecraft. It is shown that the nonequilibrium cosmic-ray anisotropy (normally observed to exhibit an amplitude in the range 20 to 50%) is field-aligned, while the equilibrium anisotropy (normally observed to exhibit an amplitude in the range 5 to 15%) is independent of the direction of the magnetic field vector. Two anomalous proton events during which pronounced anisotropies were observed with their maximum cosmic-ray fluxes directed toward the Sun are discussed. It is shown that during these proton events there were synchronous reversals of 180° in the direction of the magnetic field vector and the cosmic-ray anisotropy in association with the passage of a magnetic sector boundary past the spacecraft. These observations are interpreted as possible evidence for there being a complex loop in the magnetic field. (auth)

36694 COSMIC-RAY SOLAR FLARE EFFECT OF JANUARY 28, 1967, AS RECORDED BY NEUTRON MONITORS. Lockwood, J. A. (Univ. of New Hampshire, Durham). J. Geophys. Res., 73: 4247-60(July 1, 1968).

On January 28, 1967, at 0830 UT, sea-level neutron monitors at cutoff rigidities $P_c \leq 4.5$ GV recorded an increase presumably associated with a solar flare. From geophysical data and the characteristics of the cosmic-ray increase at Earth, it is concluded that this increase was produced by a solar flare located about 60° beyond the west limb of the Sun. The primary rigidity spectrum in the rigidity interval $1.5 < P < 5.0$ GV at 1200 UT can be represented as $\exp(-P/P_0)$ with $P_0 = 0.6$ GV. The event was marked by an absence of any large anisotropies in the flux during the onset phase. The intensity-time profile for a sea-level neutron monitor at $P_c = 1.0$ GV is consistent with anisotropic diffusion of the solar particles to the Earth, with an absorbing boundary at about 3 AU (Burlaga, 1967). The solar flare increase at sea level was followed by large anisotropies in the galactic cosmic-ray flux, which characteristically occur after large solar outbursts. (auth)

36695 RADIAL OSCILLATIONS TREATED BY THE PHASE INTEGRAL METHOD. de Freitas Pacheco, Jose Antonio (Observatoire de Paris-Meudon, France. Conselho Nacional de Pesquisas, Brazil). Compt. Rend., Ser. A and B, 266: 1170-2(Apr. 22, 1968). (In French).

A general expression was obtained for the pulsation constant Q of a variable star by using the phase integral method and the Hamiltonian formalism. (tr-auth)

36696 HIGH RESOLUTION OBSERVATIONS OF THE 30 DORADUS NEBULA AT 408 MHz. LeMarne, A. E. (Univ. of Sydney). Mon. Notic. Roy. Astron. Soc., 139: 461-9(1968).

A model of the radio emission, based on previous observations, is compared with the present results and found to be in good agreement. The results were also compared with published Balmer line isophotes, and the visual absorption of the center of the nebula was found to be at least 2^mo. An approximate model of the distribution of absorption over the nebula is suggested. The results favour a high value for the ratio of visual absorption to reddening A_v/E_{B-V}) in the nebula. (auth) (UK)

36697 SUBMILLISECOND RADIO INTENSITY VARIATIONS IN PULSARS. Craft, H. D.; Comella, J. M.; Drake, F. D. (Cornell-Sydney Univ., Puerto Rico). Nature (London), 218: 1122-4(June 22, 1968).

Two pulsars were observed with a time resolution of 0.1 ms using the 1,000-ft radio telescope at Arecibo, revealing structure and showing circular polarization within the pulses. (auth) (UK)

36698 MEASUREMENTS OF THE PULSED RADIO SOURCE CP 1919 BETWEEN 85 AND 2700 MHz. Robinson, B. J. (CSIRO, Sydney); Cooper, B. F. C.; Gardiner, F. F.; Wielebinski, R.; Landecker, T. L. Nature (London), 218: 1143-5(June 22, 1968).

The pulsed radio sources emit energy almost simultaneously over a wide frequency band, and pulses from CP 1919 have been observed with the Australian 210-ft. telescope at 85, 150, 630, 1410, and 2700 MHz. The present communciation describes measurements of the spectra of the pulses, the characteristics of the intensity variations at different frequencies, and observations of the structure and polarization of the pulses. The most surprising characteristic of the pulsed sources is stated to be the high degree of constancy of their period, combined with large and irregular variations of intensity, the time scale of these variations ranging from seconds to months. The observations suggest that the rise and fall of the pulse amplitude at lower frequencies are not generated in the source itself, but are impressed by the interstellar medium or a corona around the source. The pulse trains are not produced by a slow rotation of the plane of polarization. It has been suggested that the pulses come from a binary neutron star system and that excess activity on one star would produce a correlation between the strengths of alternate pulses, but no such effect was found on the 150 and 630 MHz records. The range of spectra for individual pulses is shown graphically. The peak flux varied by a factor of at least ten at 85 and 150 MHz, and at least five at 630 and 1,410 MHz. Peak fluxes of 100×10^{-28} W m^{-2} Hz^{-1} were observed at the two lower frequencies, and for most pulses the peak flux was greatest at 150 MHz. In general, the spectrum falls rapidly between 630 and 1,410 MHz. The spectral index between 630 and 2,700 MHz was typically −3.0 to −3.5. At 630, 1,410, and 2,700 MHz the pulses were always double, and possibly triple at times. Some polarization measurements are also described. (UK)

36699 SPECTRA OF JOVIAN MILLISECOND PULSES. Riihimaa, J. J. (Univ. of Florida, Gainesville). Nature (London), 218: 1141-3(June 22, 1968).

Spectral observations of decametric emission from Jupiter have been made recently; this communication describes some spectral characteristics of Jovian millisecond pulses, obtained with two sweep-frequency spectrographs operated from December 1967 to February 1968. The pulses, recorded from the intensity modulated display, appeared as lines of varying lengths, sometimes showing two or three maxima. The records are reproduced, and discussed. The spacing of the scintillation maxima of millisecond pulses in the frequency domain is approximately the same as that of the "diagonal patterns" of the decasecond bursts; this may be a significant link between the two different spectral types of Jupiter's decametric emission. The drifting properties of the pulses was easily recognized. The emissions appear to have a relatively narrow bandwidth, in agreement with a previous estimate based on multi-channel observations, where a value of 50 kHz or less was given for some of the pulses. The pulses may move back and forth in an irregular fashion, while sometimes they may appear to be fixed in position during two or three scans. The record gives an impression of an aperture in the frequency domain, rapidly crossed by pulses in fast frequency drift; the drift rates remain unresolved, while the aperture is in a slow, oscillatory motion. (UK)

Atomic and Molecular Physics

Refer also to abstracts 36199, 36903, 37162, 37270, 37316, and 37628.

36700 (AD-662607) LOW-ENERGY X-RAY AND ELECTRON PHYSICS. Final Report, June 1, 1964-May 31, 1967. Henke, Burton L. (Pomona Coll., Claremont, Calif. Dept. of Physics). Dec. 1967. 9p. (AFOSR-67-2751). CFSTI.

The research is concerned with a study of the complete interaction of the ultrasoft x rays with matter in the 10- to 100-Å wavelength region and of the associated production of photo- and Auger electrons in the 10- to 1000-eV region. The specific objectives of this grant period were: (1) the measurement and tabulation of ultrasoft x-ray interaction coefficients; (2) the continued development and refinement of methods for the generation, detection, and spectroscopy of low-energy x rays and electrons, and (3) the application, independently and collaboratively, of the low-energy x-ray and electron interaction physics and its associated instrumentation to the chemical and valence band analysis of matter and high-temperature plasma analysis through the ultrasoft x-ray spectroscopy of the solar corona. A resume of the results of the research and a list of publications are given. (TSS) (USGRDR)

36701 (AD-663424) COMPTON SCATTERING BY BOUND ELECTRONS. Technical Report, July 1966-May 1967. East, Larry V.; Lewis, Edwin R. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Dec. 1967. 51p. (AFWL-TR-67-120). CFSTI.

The deviation in the Compton effect due to the finite binding energy of the atomic electrons was experimentally determined for K-shell electrons of tantalum, gold, and uranium. The differential cross section for scattering of 662-keV photons by K-shell electrons was obtained by measurements of the scattered photons in coincidence with the accompanying K x ray and compared with the Klein-Nishina cross section for scattering by free electrons. The behavior of the ratio of the two cross section ratios was determined for scattering angles varying from 20 to 70°. The results indicate that the cross section ratio approaches zero as the photon scattering angle decreases to zero, and becomes >1 for scattering angles greater than 40° for Ta and 50° for Au. (USGRDR)

36702 (AD-664668) ANNUAL SUMMARY REPORT COVERING PERIOD JANUARY 1, 1967-DECEMBER 31, 1967. Hughes, Vernon W. (Yale Univ., New Haven, Conn. Gibbs Lab.). Jan. 1968. Contract Nonr-609(53). 26p. CFSTI.

A source of polarized electrons was developed which will be useful for applications in high-energy physics as well as in low-energy atomic physics. A Mott scattering polarization detector was combined with other available equipment to carry out an experiment on the collisional ionization of polarized metastable deuterium atoms. An experiment on the spin effects in electron-hydrogen scattering is being pursued. (USGRDR)

36703 (AD-666453) POSITRON ANNIHILATION IN METALS. Final Scientific Report, January 1, 1965-September 30, 1967. Parks, Ronald D. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Feb. 1968. 6p. (AFOSR-68-0318). CFSTI.

A brief summary is presented involving the study of metals by the positron annihilation technique. The most significant accomplishment was the demonstration that the positron annihilation technique is capable of yielding information about the band structure of ferromagnetic transition metals. Additional studies demonstrated the effect of ferromagnetic materials on adjacent superconducting films and provided the first information about the behavior of superconductors in the presence of large magnetic exchange fields. (USGRDR)

36704 (ANL-Trans-627) MECHANISM OF SPUTTERING OF SOLIDS. Gurmin, B. M.; Martynenko, T. P.; Ryzhov, Yu. A. Translated by Elmar K. Willp (Argonne National Lab., Ill.), from Fiz. Tverd. Tela, 10: 411-14(1968). 6p. Dep. CFSTI.

The sputtering of polycrystalline Zr, W, Mo, ZrC, and a W-Mo alloy by normal 5-, 11-, and 17-keV incident Ar^+ ions has been investigated. A comparison of the experimental values of sputtering coefficients of pure Zr and ZrC as well as of W, Mo, and W-Mo alloys shows that the part played by focusons in the sputtering is insignificant even at such ion energies that the penetration depth of ions is of a sufficient magnitude. (auth)

36705 (BNL-50102) CLASSICAL DIFFERENTIAL CROSS SECTIONS FOR SCATTERING FROM AN INVERSE POWER POTENTIAL. Felder, R. M. (Brookhaven National Lab., Upton, N. Y.). Mar. 1968. 14p. Dep. CFSTI.

Classical differential cross sections are calculated numerically for scattering from an inverse power potential $V(r) = K/r^s$. Analytical approximations are introduced which increase the efficiency of the computation severalfold, without decreasing the precision of the results. Tables of results for selected values of the exponent s are given, as are FORTRAN programs that generate cross sections for arbitrary values of s. (auth)

36706 (CEAL-1042) MEASUREMENT OF ELECTRON g FACTOR. Robinson, K. W. (Cambridge Electron Accelerator, Mass.). May 16, 1968. Contract AT(30-1)-2076. 10p. Dep. CFSTI.

If polarized electrons trapped in a magnetic bottle can be produced by spin-exchange collisions, it may be possible to use such electrons to measure the g factor of the electron to very high accuracy. This would be done by finding the radio frequencies which depolarize the electrons. The nature of the radio-frequency fields required is analyzed and some problems associated with the experiment are examined. (auth)

36707 (ISS-67/41) SULLA PRECISIONE DEL METODO FOTOGRAFICO NELLA DIFFRAZIONE DEI RAGGI X. (On the Precision of the Photographic Method in X-Ray Diffraction). Candeloro, M. S. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Nov. 14, 1967. 51p. (In Italian). Dep.

The most common errors associated with x-ray crystallographic measurements using photographic methods are examined and some improvements in the measuring conditions are deduced. The h0l and 0kl reflections of a well-known structure are reexamined on the basis of these new considerations and their accuracy is compared with previous results. (tr-auth)

36708 (N-68-15348) FRICTIONAL FORCES AND COLLISION FREQUENCIES BETWEEN MOVING ION AND NEUTRAL GASES. Stubbe, Peter (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1967. 44p. (NASA-TM-X-63079; X-615-67-631). CFSTI.

Two different terms are used in literature for the frictional force between moving ions and neutral gases. It is shown how the corresponding collision frequencies have to be defined in order to keep both terms valid. An expression is derived for the momentum-transfer collision frequency ν_{in} between ions and neutral particles as a function of temperature and the relative flow velocity $|\underline{v}_i - \underline{v}_n|$. The results indicate that for most practical applications ν_{in} may be considered as independent of $|\underline{v}_i - \underline{v}_n|$. However, for very high velocities, e.g., a convection flow from the magnetosphere into the ionosphere, this dependence may be significant. Numerical values for ν_{in} are presented. In the case of collisions between ions and their parent neutral gases, laboratory values are used for the resonant charge-exchange cross section obtained for high energies, but a correction is made for the much smaller thermal energies in the temperature range typical for ionospheric conditions. This gives rise to an enhancement of the collision frequencies, compared with the values obtained from the uncorrected charge-exchange cross sections, the amount of which depends on the particle mass. (auth) (STAR)

36709 (ORNL-AMPIC-10) BIBLIOGRAPHY OF ATOMIC AND MOLECULAR PROCESSES FOR JULY-DECEMBER 1967. (Oak Ridge National Lab., Tenn.). June 1968. Contract W-7405-eng-26. 264p. Dep. CFSTI.

This annotated bibliography contains references of interest to atomic and molecular processes research. Bibliographical sources consist of eighty scientific journals and five abstract journals. The references are classified into fourteen major categories with appropriate subcategories and are entered alphabetically in each category with the reactants or the atomic and molecular system of interest. (auth)

36710 (SC-DC-67-2399) ANALYTICAL EXPRESSIONS FOR BREMSSTRAHLUNG SPECTRA EMITTED BY HIGHLY FILTERED, THICK HIGH-Z TARGETED X-RAY DEVICES FROM 2 TO 20 MeV. Golden, J. C. Jr. (Sandia Corp., Albuquerque, N. Mex.). Apr. 1968. Contract AT(29-1)-789. 14p. (CONF-680607-7). Dep. CFSTI.

From 13th Annual Health Physics Society Meeting, Denver, Colo.

An analytical model for bremsstrahlung spectra is presented. Expressions are developed which provide a method for estimating the magnitude of the flux density, intensity, and exposure rate spectra from high-energy x-ray devices, with high Z targeted material such as tungsten and of such target thickness that scattering and energy loss processes appreciably influence bremsstrahlung production. The maximum kinetic energy of the electrons may be as high as 20 MeV. (TSS)

36711 (UCRL-18178) RADIOFREQUENCY RESONANCES IN MERCURY AND NEON ATOMS EXCITED BY ELECTRON IMPACT. McHarris, Orilla Ann (California Univ., Berkeley. Lawrence Radiation Lab.). May 24, 1968. Contract W-7405-eng-48. 85p. Dep. CFSTI.

Thesis.

Dehmelt's technique of producing and aligning an excited atomic state by electron bombardment and then detecting an rf resonance of the state by optical means was applied to neon for the first time.

The metastable $(2^2P_{\frac{1}{2}}3^2S_{\frac{1}{2}})_2$ state was produced by collision with electrons of about 25 eV, and the resonance was detected as a change in absorption of the 6143 Å resonance radiation corresponding to a transition from the metastable state to the higher $(2^2P_{\frac{1}{2}}3^2P_{\frac{1}{2}})_2$ state. The measured g_j value agrees with that given by the atomic beam method. The magnetic field was calibrated with the rf resonance of the mercury 6^3P_2 state; this state was also produced and aligned by electron impact, and the resonance was detected as a change in absorption of the resonance radiation to the 7^3S_1 state. In a further application of this technique, the lifetime of the mercury 6^3P_2 magnetic sublevels was obtained (as a function of the pressure of the mercury vapor). The equation for the rf resonance line was derived, and with the use of the equation the m-state lifetime was obtained both from the variation of the line width with rf power and also from the separation of the two maxima in the strongly rf-broadened line. For pressures of 4 to 7×10^{-3} torr the lifetime was found to be 1 to 0.5×10^{-5} sec. These values are similar to those obtained by Baumann, although in order to agree with the equation for the resonance line, his values should be multiplied by a factor of 2. The relationship of the lifetime to the most likely collision processes is discussed. (auth)

36712 (UCRL-Trans-10250) BEHAVIOR OF THE STARK EFFECT WITH SUDDEN FIELD VARIATIONS. Rausch von Traubenberg, H.; Gebauer, R.; Schroedinger, E. Translated by Benjamin Thayne for Univ. of California Lawrence Radiation Lab., Livermore, from Z. Phys., 78: 309-17(1932). 16p. Dep. CFSTI.

For the nonadiabatic case the Stark effect was investigated in the presence of sudden field variations. It was shown that the splitting corresponds to the prevailing field value even when the adiabatic condition is not fulfilled. (auth)

36713 AN AUTOMATIC EXTRAPOLATION METHOD FOR THE VALUE OF THE INTENSITY OF THE HD^+ BEAM COMING FROM THE ELECTROSTATIC IMPACT ION SOURCE. Pascalau, M. (Institut de Physique Atomique, Cluj). Rev. Roum. Phys., 13: 173-4(1968). (In Rumanian).

An automatic extrapolation method using a recorder with two coordinates and a method using a standard recorder are described. The extrapolation chain is traced in each. The circuit diagram of the comparative circuit is given. (J.S.R.)

36714 COMBINED DOPPLER AND COLLISION BROADENING. Gersten, Joel I.; Foley, Henry M. (Columbia Univ., New York). J. Opt. Soc. Amer., 58: 933-7(July 1968).

The combined effect of Doppler and collision broadening of spectral lines is studied by means of the statistical correlation function for the time-varying amplitude of classical oscillators. It is shown that at high pressures (mean-free path smaller than wavelength) the line shape is Lorentzian with a width which is the sum of the conventional collision broadening and a Doppler contribution which decreases with increasing pressure, consistent with Dicke's results. (auth)

36715 ELECTRON PENETRATION AND THE ATOMIC NUMBER CORRECTION IN ELECTRON PROBE MICROANALYSIS. Philibert, J.; Tixier, R. (Institut de Recherches de la Siderurgie Francaise, Saint-Germain-en-Laye, France). J. Phys., D, 1: 685-94(June 1968).

The number of ionizations on a given j shell in any electron-bombarded target was calculated analytically by means of the Bethe formulae. A general formula for the atomic number correction was derived in the form of an equation using parameters that are functions of target composition and accelerating voltage. This equation allows calculation of the penetration effect to be readily carried out. The electron range, in terms of beam energy, was also calculated. Finally, it was shown that the correction is different in the case of thin-target analysis. (auth) (UK)

36716 IONIZATION STATES OF SOME UNIDENTIFIED LINES IN NITROGEN. Fink, Uwe (Univ. of Arizona, Tucson). J. Opt. Soc. Amer., 58: 937-40(July 1968).

The charge components of a nitrogen ionic beam accelerated by a Van de Graaff machine and sent through a carbon-target foil were deflected by means of an electrostatic field. The resulting Doppler shift permitted the identification of the ionization state of a number of unidentified lines in the spectrum of nitrogen. These lines do not fit into the known energy-level schemes of nitrogen ions. The possibility that they stem from multiple-electron-excitation levels is discussed. (auth)

36717 SUBSHELL BINDING ENERGIES OF ATOMS AND IONS FROM HYDROGEN TO ZINC. Lotz, Wolfgang (Institut fuer Plasmaphysik, Garching, Ger.). J. Opt. Soc. Amer., 58: 915-21(July 1968).

Binding energies of electrons in all subshells of free atoms and of ions of all ionization stages of the elements hydrogen through zinc (Z = 30) are given with full regard to experimental values, in the sense that experimental values are preferred in all cases of doubt. (auth)

36718 HYPERFINE STRUCTURE OF ^{209}Bi IN THE $6p^2(^3P_0)7s^4P_{\frac{1}{2}}$ STATE. Chuckrow, R.; Magnante, P. C.; Stroke, H. H. (New York Univ., N. Y.). J. Opt. Soc. Amer., 58: 922-3(July 1968).

The hyperfine-structure separation of the $6p^2(^3P_0)7s^4P_{\frac{1}{2}}$ state of ^{209}Bi was measured in the 4722-Å transition with a grating spectrograph. The measurement was carried out because a precise value was required in our studies of the spectra of radioactive bismuth isotopes. Our result is $\Delta\nu(^4P_{\frac{1}{2}}) = 819.5 \pm 3.1$ mK. It differs from the previously quoted value of 830 mK, and agrees with a recent result of Dickie and Kelly. (auth)

36719 REACTIONS OF IONS AND EXCITED ATOMS OF THE INERT GASES. Brocklehurst, B. (Univ. of Sheffield, Eng.). Quart. Rev. (London), 22: 147-59(1968).

The subject is reviewed under the following headings: Introduction; energy levels; low-pressure studies (photosensitized reactions, mass spectrometry, ion–molecule reactions–charge transfer, ionizing reactions of excited states); high-energy irradiation (decay of excitation in the pure gases, sensitized processes, ionization yields, luminescence of irradiated gases, radiation chemistry); excitation in discharges (lasers, discharge afterglows). 59 references. (UK)

36720 EFFECT OF ELECTRON EXCHANGE IN THE EXCITATION OF ATOMIC HELIUM BY ELECTRON IMPACT. Bell, K. L.; Kennedy, D. J.; Kingston, A. E. (Queen's Univ., Belfast). J. Phys., B, 1: 322-4(Mar. 1968).

The effect of electron exchange on the cross sections for excitation of the ground state of helium to n^1P and n^1D states by electron impact is investigated by employing the Rudge and Ochkur approximations to the exchange scattering amplitude. Comparison is made with experimental data and it is found that the inclusion of exchange in these approximations does not remove the existing discrepancies between theory and experiment at medium impact energies. (auth) (UK)

36721 MEASUREMENTS OF CROSS SECTIONS FOR THE IONIZATION OF Na^+ TO Na^{2+} AND K^+ TO K^{2+} BY ELECTRON IMPACT. Peart, B.; Dolder, K. T. (Univ. of Newcastle-upon-Tyne, Eng.). J. Phys., B, 1: 240-4(Mar. 1968).

Cross sections were measured for the reaction $Na^+ + e \rightarrow Na^{2+} + 2e$ for electrons with energies between threshold and 3500 eV. Similar cross sections of K^+ ions were also measured for electron energies up to 3000 eV. The errors are estimated to be less than ±6% over a wide range of electron energies, and the results agree with those of Hooper et al., which were confined to electron energies up to 1000 eV. (auth) (UK)

36722 ASSUMPTION-INDEPENDENT SINGLE-PARTICLE WAVE FUNCTIONS FOR POSITRONS IN SOLIDS: APPLICATIONS TO ANGULAR DISTRIBUTIONS IN Al AND Si. Stroud, D.; Ehrenreich, H. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 171: 399-407(July 10, 1968).

The single-particle positron wave function in a solid may be calculated by a new technique which is entirely free of any theoretical assumptions by virtue of its use of experimental x-ray form factors to construct the potential. The results obtained accordingly form an excellent starting point for a systematic treatment of many-body effects in electron–positron annihilation processes. The positron wave function, which has the full crystal symmetry, is used together with pseudopotential wave functions for the valence electrons to compute the angular distribution of annihilation radiation from Al and Si for several crystal orientations. Agreement with experiment is excellent. The angular distribution from Al is found to be practically isotropic, despite the angular variation of the positron wave function. The substantial anisotropy in Si is reproduced within experimental error. Use of a constant positron wave function somewhat reduces the agreement. The calculated curves are little affected, however, by appreciable changes in the pseudopotential coefficients, indicating that positron annihilation is an insensitive probe of semiconductor band structures. The validity of using pseudopotential electron wave functions in the present context is discussed. The approximation is found to be excellent for most of the angular distribution because the positron is largely excluded from the core, where pseudo-wave-functions are incorrect. Accordingly, unlike positron lifetimes, the angular distribution can be well explained by an independent-particle model, even when it displays considerable anisotropy. (auth)

36723 SINGLE-QUANTUM ANNIHILATION OF POSITRONS. Mazaki, Hiromasa; Nishi, Masatsugu; Shimizu, Sakae (Kyoto Univ.). Phys. Rev., 171: 408-16(July 10, 1968).

Total cross sections for the single-quantum annihilation of positrons in five elements have been measured. The monoenergetic positron beam was obtained by the use of a Siegbahn–Slätis intermediate-image spectrometer mounted with a ^{22}Na source. Thin foils of Sn, Ta, Au, Pb, and U were used, successively, as targets mounted at the focal point of the spectrometer. The monoenergetic γ photons due to the single-quantum annihilation were measured in coincidence with accompanying K x rays from the target, using the NaI(Tl) scintillation detectors. The effect of the finite target thickness was evaluated carefully by measuring the energy distribution of incident positrons in the thin target. The exponent of Z in the total cross section of this process for the incident positrons with 300-keV kinetic energy has been found to be 4.93 ± 0.31, in agreement with calculations by Johnson et al. The energy dependence of the total cross sections, measured for Pb and U in the positron energy range from 250 to 400 keV, has also been found to be in fairly good agreement with theoretical values calculated by other workers using the relativistic Coulomb wave functions for both the K-shell electron and the incident positron. (auth)

36724 RADIATIVE AND MULTIPHONON RELAXATION OF RARE-EARTH IONS IN Y_2O_3. Weber, M. J. (Raytheon Research Div., Waltham, Mass.). Contract DA44-009-AMC-1727(E). Phys. Rev., 171: 283-91(July 10, 1968).

Spontaneous-emission probabilities for electric- and magnetic-dipole transitions from excited electronic states of Pr^{3+}, Nd^{3+}, Eu^{3+}, Er^{3+}, and Tm^{3+} impurities in Y_2O_3 are calculated using eigenstates in intermediate coupling and experimental intensity parameters. The predicted radiative lifetimes are in good agreement with experimental lifetimes measured using pulsed-selective-excitation techniques for those levels where unit quantum efficiency is expected. Discrepancies do exist, however, which indicate the importance of J-state mixing and possible breakdown of the closure approximation used in Judd and Ofelt's treatment. Nonradiative decay rates were determined by subtracting the radiative contribution from the observed lifetime. The rates of multiphonon emission in Y_2O_3 exhibit a systematic variation with proximity of the next-lowest level and contribute significantly to the decay for levels having energy gaps to the next-lowest level of less than 3000 cm^{-1}. Selection-rule restrictions are evident from the reduced relaxation rates for the $^5D_1$ levels of Eu^{3+}. The concentration dependence of the excitation spectra and excited-state lifetimes of Tm^{3+} were investigated to establish the importance of ion-pair relaxation; however, these processes were generally avoided. (auth)

36725 PHOTOELECTRIC CROSS SECTIONS IN THE keV RANGE. Brysk, H.; Zerby, C. D. (Union Carbide Corp., White Plains, N. Y.). Contract DA-49-146-XZ-511. Phys. Rev., 171: 292-8(July 10, 1968).

Photoelectric cross sections have been computed using bound-state wave functions and potentials from a relativistic Dirac–Slater self-consistent-field program and numerical integration for the continuum wave functions and the matrix elements. Results for aluminum in the range 1 to 150 keV and for uranium in the range 80 to 150 keV are compared with existing experimental and theoretical data, with particular emphasis on the angular distributions. (auth)

36726 ROLE OF ELECTRONIC STRUCTURE IN DETERMINING THE CHARGES OF FAST IONS IN MATTER. Wolke, R. L. (Univ. of Pittsburgh). Phys. Rev., 171: 301-9(July 10, 1968).

Some equilibrium charge-state distributions of 7 to 11×10^8 cm/sec ^{10}B, ^{12}C, and ^{13}C ions in plastic films and in carbon have been determined by spectrometry of the recoils from the $^{12}C(d,\alpha)$, $^{12}C(d,d')$, and $^{12}C(d,p)$ reactions at 15 MeV. A simple phenomenological model is presented for the capture and loss of electrons in a beam at charge-state equilibrium. The present experimental results, together with all previously published data on the equilibrium charge states in plastics of ions in the second period of the periodic table, are analyzed within the framework of the model for the influence of the electronic structure of the ions. A universal correlation with the respective ionization potentials is found when the "same" electrons are compared in all ions. Indications are that the same kind of correlation prevails also in heavier ions. The model and its resultant correlations focus upon the equality of capture and loss cross sections as the "stripping" criterion for each electron. (auth)

36727 SPUTTERING OF METAL NITRIDES AND BORIDES BY Cd^+ IONS HAVING ENERGIES UP TO 500 eV. Martynenko, T. P. (Moscow Aeronautical Inst.). Sov. Phys.-Solid State (Engl. Transl.), 9: 2887-8(June 1968).

Translated from Fiz. Tverd. Tela, 9: 3655-6(Dec. 1967).

Sputtering coefficients for LaB_6, ZrB_2, TiB_2, ZrN, TiN, VN, and $MoSi_2$ were measured using Cd^+ ions in the energy range 100 to 500 eV. The general nature of curves showing dependence of sputtering on ion energy is the same for nitrides, borides, and the corresponding pure metals. The sputtering coefficients increase linearly with the energy of the incident ions. The metal nitrides are sputtered more strongly than the corresponding pure metals and borides. (A.G.W.)

36728 INELASTIC COLLISIONS BETWEEN EXCITED ALKALI ATOMS AND MOLECULES. IV. SENSITIZED FLUORESCENCE AND QUENCHING IN MIXTURES OF CESIUM WITH N_2, H_2, HD, AND D_2. McGillis, D. A.; Krause, L. (Univ. of Windsor, Ont.). Can. J. Phys., 46: 1051-7(May 1, 1968).

$6\,^2P_{\frac{1}{2}} \rightleftharpoons 6\,^2P_{\frac{3}{2}}$ mixing and $6\,^2S_{\frac{1}{2}} \leftarrow {}^2P_{\frac{3}{2},\frac{1}{2}}$ quenching in cesium,, induced in collisions with ground-state N_2, H_2, HD, and D_2 molecules, were investigated using techniques of sensitized fluorescence. Mixtures of cesium vapor and the gases, in which the cesium vapor pressure was kept very low to avoid multiple scattering, were irradiated with each component of the cesium resonance doublet in turn. The fluorescence which contained both components of the doublet was observed in a direction perpendicular to that of the exciting beam. Measurements of the relative intensities of the fluorescent components yielded the following cross sections for mixing and quenching. For Cs–N_2 collisions: $Q_{12}(^2P_{\frac{3}{2}} \rightarrow {}^2P_{\frac{1}{2}}) = 4.7$ Å^2, $Q_{21}(^2P_{\frac{1}{2}} \leftarrow {}^2P_{\frac{3}{2}}) = 25$ Å^2, $Q_{10}(^2S_{\frac{1}{2}} \leftarrow {}^2P_{\frac{1}{2}}) = 77$ Å^2, $Q_{20}(^2S_{\frac{1}{2}} \leftarrow {}^2P_{\frac{3}{2}}) = 69$ Å^2. For Cs–H_2 collisions: $Q_{12} = 6.7$ Å^2, $Q_{21} = 44$ Å^2, $Q_{10} = 7$ Å^2, $Q_{20} = 5$ Å^2. For Cs–HD collisions: $Q_{12} = 4.8$ Å^2, $Q_{21} = 32$ Å^2, $Q_{10} = 4$ Å^2, $Q_{20} = 3$ Å^2. For Cs–D_2 collisions: $Q_{12} = 4.2$ Å^2, $Q_{21} = 28$ Å^2, $Q_{10} = 8$ Å^2, $Q_{20} = 7$ Å^2. The Cs–N_2 and Cs–H_2 cross sections supersede the values published previously (McGillis and Krause 1967). The cross sections Q_{21} appear to exhibit resonances with molecular rotational transitions. (auth) (Canada)

36729 SPUTTERING EXPERIMENTS WITH 1- TO 5-keV Ar^+ IONS. III. MONOCRYSTAL TARGETS OF THE HEXAGONAL METALS Mg, Zn, Zr, AND Cd. Robinson, Mark T.; Southern, A. L. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Appl. Phys., 39: 3463-75(June 1968). (ORNL-P-3473).

Sputtering yields and ejection patterns have been observed during the irradiation of $\langle 0001 \rangle$, $\langle 10\bar{1}0 \rangle$, and $\langle 11\bar{2}0 \rangle$ crystals of Mg, Zn, Zr, and Cd with normally incident 5-keV Ar^+ ions. A few observations were made at other energies as well. Except for the $\langle 11\bar{2}0 \rangle$ crystals of Zn and Cd, Onderdelinden's sputtering model accounts satisfactorily for the orientation dependence of the yields. With the same exceptions, the model also accounts for the relationship of the yields of these hcp metals to those of the fcc metals Al, Cu, and Ag. The Zn and Cd $\langle 11\bar{2}0 \rangle$ crystals show yields about 50% greater than expected from this model. They also show unusual ejection patterns that cannot be related to the undistorted hcp structure. These effects are attributed to radiation damage. The other crystals show preferred ejection along the directions $\langle 11\bar{2}0 \rangle$, $\langle 0001 \rangle$, $\langle 20\bar{2}3 \rangle$, $\langle 40\bar{4}3 \rangle$, and (possibly) $\langle 6\bar{4}23 \rangle$. The last three are not closely and uniformly spaced rows of atoms. Their importance in the ejection patterns, as well as the close agreement of hcp and fcc yields, make it unlikely that long sequences of focusing collisions play a significant role in the sputtering of metals. (auth)

36730 TRANSMISSION SPUTTERING OF THIN FILMS BY LOW-ENERGY HYDROGEN IONS. Robison, Charles H. (Univ. of California, Livermore). J. Appl. Phys., 39: 3441-6(June 1968).

An experimental measurement of transmission sputtering (sputtering from the downstream face of a target foil) was performed with 15-keV molecular ions of hydrogen and deuterium normally incident on polycrystalline gold films several hundred angstroms thick. The sputtered atoms were detected by using neutron activation. A modified form of a theoretical sputtering formula due to Pease was found to fit the data within a factor of two, except in the circumstance where the average energy of the primary knock-on atom was less than the displacement energy. The modifications included taking into account: the energy loss of the incident particles in passage through the film; the average energy of the moving primary knock-on atoms; and the fraction of the incident beam scattered before reaching the downstream face of the film. (auth)

36731 KINEMATICS OF DESORPTION BY EMERGING HIGH-ENERGY ELECTRONS. Danforth, W. E.; Pollard, John H. (Bartol Research Foundation, Swarthmore, Pa.). Contract AT(30-1)-2730. J. Appl. Phys., 39: 3393-3400(June 1968). (NYO-2730-70).

With certain systems the cross section for desorption of surface atoms by low-energy electrons is negligibly small. Desorption will not take place unless the electrons have sufficient energy to impart the required momentum by direct exchange. The present work is relevant to such systems. Given a high-energy electron traversing a solid and emerging from the surface, there exists a

finite probability that the electron will suffer a deflection in the Coulomb field of the nucleus of a surface atom and thereby impart sufficient momentum to the atom to result in its desorption. Assuming that a value for the binding energy is given, the several considerations which must have a part in the computation of the desorption cross section as a function of electron energy are set forth. Calculated values are presented for the case of adsorbed thorium over a wide range of assumed binding energies and for electron energies up to 2 MeV. Results of the mechanical integrations are plotted in such a form that cross sections for other atomic species can be obtained by simple calculation. (auth)

36732 OPTICAL TRANSITION PROBABILITIES OF THE CONFIGURATIONS $3p^5$ 4s–$3p^5$ 5p OF ARGON I. Wende, B. (Physikalisch-Technische Bundesanstalt, Berlin). Z. Phys., 213: 341-51 (1968). (In German).

Optical transition probabilities of the configurations $3p^5$ 4s – $3p^5$ 5p of Argon I were determined in a wall-stabilized arc plasma compared with the theoretical results for different types of spin–orbit coupling. Mostly the differences in the results for LS–jl- and intermediate-coupling are small compared with the deviations of the experimental values. Therefore it may be presumed that in some cases not the assumption of an approximately valid coupling scheme is responsible for the errors of the theoretical transition probabilities, but the other quantum mechanical approximation processes. (auth)

36733 ANGULAR CORRELATION OF POSITRON ANNIHILATION RADIATION CALCULATED FROM ATOMIC HARTREE–FOCK ORBITALS. Hautojaervi, P. (Univ., Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI, No. 270, 8p.(Feb. 1968).

Angular correlations of two-photon annihilation radiation from Al, Si, Ge, and Se were calculated by using constant positron wave function and atomic Hartree–Fock orbitals of valence electrons. Agreement with the measured curve is good for Se. (auth)

36734 EFFECT OF AN EXTRANUCLEAR ELECTRON ON THE MUONIC ATOM. Best, B. G.; Kim, D. Y. (Univ. of Saskatchewan, Regina). Can. J. Phys., 46: 1253-4(May 15, 1968).

The effect of an extranuclear electron on the hydrogenic muonic atom in the ground state has been evaluated by means of a variational method. The energy-level shift due to this effect was found to be about 0.5% of the total energy of the muonic atom. (auth) (Canada)

36735 THE ELECTRONIC ISOTOPE SHIFT IN THE LYMAN BANDS OF H_2, HD, AND D_2. Wilkinson, P. G. (National Research Council of Canada, Ottawa). Can. J. Phys., 46: 1225-35 (May 15, 1968).

Five absorption bands in the $B\,^1\Sigma_u^+ - X\,^1\Sigma_g^+$ transition of each of the molecules H_2, HD, and D_2 were obtained under high resolution in the 1050 to 1130 Å region in order to determine precise values of the electronic energy (T_e) and the change (ΔT_e) upon isotopic substitution. The fifth order of a 21-ft concave diffraction grating was employed. The experimental results are $T_e(H_2)$ = 91,699.54 cm^{-1}, $T_e(HD)$ = 91,698.88 cm^{-1}, and $T_e(D_2)$ = 91,698.83 cm^{-1}. These reveal a surprisingly small shift (<1 cm^{-1} in ΔT_e) and show that the electronic energies (T_e) are in remarkably close agreement (5.4 to 7.8 cm^{-1}) with ab initio calculations. (auth) (Canada)

36736 EXPERIMENTAL DETERMINATION OF THE LIFETIMES IN MAGNESIUM AND CALCIUM ATOMS. Karstensen, Frithjof; Schramm, Juergen (Univ., Kiel). Z. Astrophys., 68: 214-21(1968). (In German).

The lifetime of the 4 ^{1}D term of Mg was found to be 59 nsec and that of the Ca term 4 $^1F^\circ$ to be 33 nsec. *f* values of transitions from these terms were determined with help of branching ratios calculated from the tables of Bates and Damgaard. (auth)

36737 KINEMATIC INVESTIGATIONS OF ION–NEUTRAL COLLISION MECHANISMS AT ~1 eV. Matus, L.; Opauszky, I.; Hyatt, D.; Masson, A. J.; Birkinshaw, K.; Henchman, M. J. (Univ. of Leeds, Eng.). Discuss. Faraday Soc., No. 44, 146-56(1967).

A new pulsing technique is described for the study of ion–neutral collision processes at energies of ~1 eV. Short, high voltage pulses applied to the repeller plate of a mass-spectrometer ion source can produce reactant ion beams of constant velocity. Velocity analysis of both reactant and product ions is achieved through pulsed defocusing of the ion beam, using a time-of-flight technique. The collision mechanisms of the reactions $CD_4^+ + CD_4 \rightarrow CD_5^+ + CD_3$, $HD^+ + HD \rightarrow H_2D^+ + D$, and $HD^+ + HD \rightarrow HD_2^+ + H$ are shown to involve complex formation in lab energies of 1.7 and 0.36 eV respectively. The following nonreactive collision processes were also studied: $He^+ + H_2 \rightarrow He^+ + H_2$ and $C_2H_4^+ + C_2H_6 \rightarrow C_2H_4^+ + C_2H_6$. The latter forms a complex which dissociates to give back the original reactants, whereas the former does not proceed via a complex. This is explained by the inability of the former system to convert relative translational energy into internal energy of the complex. For the latter process, this conversion is very much easier. (auth) (UK)

36738 THE EXCITATION OF THE GROUND STATE OF HELIUM TO THE 2^1P STATE BY FAST ELECTRONS. Kennedy, D. J.; Kingston, A. E. (Queen's Univ., Belfast). J. Phys., B, 1: 195-203(Mar. 1968).

The first Born approximation is used to calculate the cross section for electron excitation of the ground state of helium to the 2 ^{1}P state. Various ground- and excited-state wave functions are employed and the calculations are performed using both the length and velocity formulations of the Born approximation integrals. The most accurate calculations give a first Born cross section which is accurate to better than 2%. The total and differential cross sections are compared with experiment; the agreement is good. (auth) (UK)

36739 EXCITATION OF HELIUM BY FAST ELECTRONS. Bell, K. L.; Kennedy, D. J.; Kingston, A. E. (Queen's Univ., Belfast). J. Phys., B, 1: 204-17(Mar. 1968).

A six-parameter ground-state wave function and modified hydrogenic excited-state wave functions are used to calculate the first Born approximation cross section for electron excitation of the ground state of helium to the n ^{1}P(n = 2 to 6) and n ^{1}D(n = 3 to 6) states. Calculations are carried out using both the length and velocity formulations of the Born approximation integrals, and these show that the total cross sections are accurate to about 4%. The total and differential cross sections are compared with other calculations and with experiment. At large electron impact energies the theoretical and experimental total cross sections do not agree. (auth) (UK)

36740 THEORY OF COLLISION-INDUCED TRANSLATIONAL ABSORPTION. Sears, V. F. (Chalk River Nuclear Labs., Ont.). Can. J. Phys., 46: 1163-72(May 15, 1968). (AECL-3087).

A theory of the line shape for collision-induced translational absorption in rare-gas mixtures is developed. The reduced line-shape function is expanded in terms of the quantity ρ/σ, typically of the order of 0.1, where ρ is the range of the induced dipole moment and σ is the size of the repulsive core of the interatomic potential. The calculation is based on the special properties of the exponential model for the induced electric dipole moment. The temperature is assumed to be sufficiently high that the motion of the atoms can be treated classically, while the density is assumed to be sufficiently low that only binary collisions are important and intercollisional correlation effects are negligible over the frequency range of interest. A least-squares comparison of theory with experiment yields values for ρ and the magnitude of the induced moment for Ne–Ar and He–Ar pairs. (auth) (Canada)

36741 STOPPING POWER OF 0.5- TO 3.5-MeV α PARTICLES IN Cu–Au ALLOYS. Ehrhart, P.; Rupp, W.; Sizmann, R. (Univ., Munich). Phys. Status Solidi, 28: K35-7(July 1, 1968).

The energy loss of α particles passing through thin foils (0.3 to 1 mg/cm^2) of Cu, Au, and Cu–Au alloys was investigated by determining the change from entrance energy E_1 to exit energy E_2. The resulting atomic dE/dx in pure Cu and Au are plotted as a function of the mean energy $E = (E_1 + E_2)/2$. The experimentally determined energy losses in eight different Cu–Au alloys at different α energies were compared with values calculated from Bragg's additivity rule of atomic stopping powers of the components. General agreement within 2% was found. (A.G.W.)

36742 EQUILIBRIUM SOLUTIONS FOR PARTIALLY IMMERSED RELATIVISTIC ELECTRON BEAMS. Neugebauer, W. (General Electric Co., Schenectady, N. Y.). IEEE (Inst. Elec. Electron. Eng.) Trans. Electron Devices, ED-14: 686-93(Oct. 1967).

Equilibrium equations relating the beam radius and axial electron velocity to easily measurable external beam parameters are developed for solid, relativistic beams. The beam parameters are tunnel voltage, beam current, axial magnetic field, cathode magnetic field, tunnel radius, and cathode radius. The equations are sufficiently complex to warrant the use of a digital computer if many cases are to be evaluated. Error indicators are formulated to prevent use of the relations beyond their range of validity. The equilibrium solutions for relativistic electron beams from unshielded cathodes show that the required magnetic focusing field is lower than that computed from nonrelativistic formulas. The angular magnetic field produced by the beam itself aids in focusing the electrons. The potential depression due to space charge is analyzed. Correction curves are given which allow the use of nonrelativistic equations in predicting equilibrium behavior. The maximum possible microperveance of relativistic beams is shown to be lower than the classical value of 25.4. (BBB)

36743 MEASUREMENT OF SOME ENERGY LEVELS AND LIFETIMES FOR COLLISIONALLY EXCITED BORON. Luther, Marvin LeRoy. Blacksburg, Va., Virginia Polytechnic Inst., 1967. 46p.

Thesis.

A source capable of producing isotopically pure spectra was utilized to examine the spectrum of highly excited boron in the region from 3400 to 7200 Å. The technique has the further advantage of enabling a direct measurement of the lifetimes of the excited states to be made. The source is capable of producing a wide variety of ionization levels and excited states at one time. It consists of a radiating beam of particles from a Van de Graaff accelerator, which are electronically excited by collisions in a thin carbon foil. The accelerator beam, after passing through the foil, is viewed at right angles to its path by a one-meter Czerny–Turner spectrograph of moderate speed (f/8.5) and dispersion (16.84 Å/mm). The entrance slit is aligned parallel to the beam which is collimated so as to be only .80 mm high and 6.25 mm deep. The $^3D-^3F^0$ transition of B I, the $^2D-^2F^0$ transition of B III, and the unidentified 7000 Å line of boron were observed. Due to the large number of collisions which the beam particles suffer in passing through the foil, the excitation which is observed can be assumed to occur in the foil and the exponential decreases in intensity along the spectral lines used to measure the mean lifetimes of particular states. The decrease in intensity of all three lines in a distance of 14 mm was less than 50% and as the beam velocity was about 7×10^8 m/sec, the lifetimes of these excited states are at least 1.5 mμsec long. (Disser. Abstr.)

36744 SURFACE POTENTIAL OF METAL SURFACES UNDER ELECTRON BOMBARDMENT IN HIGH VACUUM. Petit-Clerc, Yves; Carette, J. D. (Univ. Laval, Quebec). Vacuum, 18: 7-16(Jan. 1968). (In French and English).

Behavior of surface potentials of metals in vacuum within the 10^{-6} to 10^{-7} torr range, under the influence of an incident electron beam was studied. Local modifications of the potential were measured with an improved Kelvin probe. Surface potential modifications were studied as a function of the electron energy, the time of exposure to the beam, and the current density of the beam. Negative potentials were induced by incident electrons; and positive potentials were caused by positive ions formed by electron impact in the gun. The life of those local potential modifications is highly pressure dependent. The apparatus is described and illustrated by a block diagram. The surface potential of an Al plate before bombardment and after bombardment at 14 eV for 2 minutes is illustrated as indicative of experimental results. Peaks formed on a stainless steel surface at a pressure of 10^{-7} torr after a bombardment of 3 min with electrons ranging in energy from 8.2 to 43 eV show energy dependence, a splitting of the peak being noted above 17 eV. A knowledge of the nature of these effects is of great interest to workers using low-energy electron beams in high vacuum, as for the study of the ionization threshold of atoms and molecules by electron collision, for the measurement of the reflection coefficient of electrons from surfaces in vacuum, and also for measurements of photon emission by low energy electron bombardment of surfaces. (BBB)

36745 ELASTIC AND CHARGE-REARRANGING DIFFERENTIAL CROSS SECTIONS FOR COLLISIONS OF H^+ AND H_2^+ WITH WATER MOLECULES. Cable, Peter George. College Park, Md., Univ. of Maryland, 1967. 132p.

Thesis.

This thesis represents a twofold undertaking: (i) The description of an apparatus constructed to study atomic collision phenomena; (ii) the report of an experiment performed with the apparatus. The modulated crossed beam apparatus which was constructed enables one to study the energetics and product ion angular distributions of ion–neutral elastic and charge rearranging collisions. The essential components of the apparatus included an ion source, which produced a nearly monoenergetic and mass analyzed ion beam; a modulated, molecular beam source for condensable gases; and a product ion energy analyzer and detector system. The secondary ion analyzer–detector could be rotated about the crossed beam interaction region through an angular range $-45° \leq \theta \leq 120°$ with respect to the primary ion beam. Amplification of the scattering signal and phase sensitive detection were employed to achieve good signal-to-noise ratio. The system was used to study the collisions of H^+ and H_2^+ with the H_2O molecules over an incident ion energy range 200 eV $\leq E \leq$ 500 eV. Contributions from both elastic and inelastic scattering were observed and measured. The elastic scattering data were used to deduce the form of the repulsive part of the ion–molecule potential experienced in close collisions. For this purpose an inversion formula derived by Firsov was employed to obtain the potential function directly from the differential cross section at each of several energies. The potential energies correspond to ion–molecule separations of fractions of an angstrom. The inelastic scattering data, including product ion angular and energy distributions, have been discussed qualitatively and compared with the results of previous studies. Possible reaction mechanisms to account for the inelastic contribution were reviewed in detail and arguments were given to show that the present data favor dissociative charge exchange as the dominant inelastic process. (Disser. Abstr.)

36746 X-RAY AND ELECTRON SCATTERING FACTORS FOR MANY-ELECTRON ATOMIC SYSTEMS. Benesch, Robert (Univ. of Alberta, Edmonton); Malli, Gulzari. Int. J. Quant. Chem., 2: 371-89(May 1968).

Analytical expressions were developed for the x-ray and electron scattering factors for a many-electron atomic system when the single configuration wave function of the system was written as a sum of Slater determinants of spin orbitals. The radial part of the orbital was expanded in terms of Slater-type orbitals (STO's). The expressions so developed were used to calculate the coherent and incoherent x-ray and electron scattering factors and intensities for all the neutral atoms up to Kr (Z = 36) and for some positive and negative ions of chemical interest. The results obtained were used to test the value of Hartree–Fock wave functions for the evaluation of one-electron properties of many-electron atomic systems. (BBB)

36747 TWO-PHOTON DECAY OF METASTABLE TRIPLET HELIUM. Drake, G. W. F.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Institution Astrophysical Observatory, Cambridge, Mass.). Astrophys. J., 152: L121-3(June 1968).

Mathis (1957) pointed out that the two-photon decay of metastable $2\,^3S$ helium is an important atomic process that affects the population of the levels of He in a dilute radiation field, and he gave estimates of its efficiency. However, the basic formulation employed by Mathis and reproduced by Levinson and Nikitin (1965) is incorrect. A preliminary study based on the approximations used by Mathis suggests that the resulting probability of the two-photon decay will not exceed 10^{-7}/sec, a limit that is 2 orders of magnitude smaller than the value calculated by Mathis. (W.D.M.)

36748 MEASUREMENT OF THE LIFETIMES OF THE 3p LEVELS OF Ne I BY MEANS OF A BEAM OF Ne^+ IONS. Denis, Alain; Desesquelles, Jean; Dufay, Maurice (Faculte des Sciences, Lyon). Compt. Rend., Ser. A and B, 266: 1016-19(Apr. 8, 1968). (In French).

The lifetimes of the 3p levels of Ne I were measured by observation of the radiative de-excitation in vacuum of an atomic beam of accelerated Ne. The results were compared with the results of previous studies. The measurement method was discussed. (tr-auth)

36749 SIMPLE ANALYTICAL EIGENFUNCTIONS OF ELECTRONS IN THOMAS–FERMI ATOMS. Tietz, T. (Univ. of Lodz, Poland). Z. Naturforsch., 23a: 191-2(Jan. 1968).

Analytical solutions are given for practical use of the Schroedinger equation for the approximate Thomas–Fermi potential of the author. (M.O.W.)

36750 SECULAR CHANGES IN ATOMIC "CONSTANTS." Atkinson, Robert d'E. (Indiana Univ., Bloomington). Phys. Rev., 170: 1193-4(June 25, 1968).

With the modern definitions of the centimeter and second, the numerical value for the velocity of light is shown to be inversely proportional to $\alpha^2\beta$, where $\beta \equiv m/M_p$. The proportionality factor involves the two numbers adopted in the definitions, together with two pure numbers which have not actually been computed yet, but undoubtedly will be; each may contain small correction terms involving α and β, but apparently nothing else. Thus if α and β is secularly variable, c is inversely proportional only to $\alpha^2\beta$ in the first approximation; and if α and β are both constant, c is constant in all approximations. It is possible to formulate a similar kind of definition for the gram, and in that case $\hbar$ is independent of α and β, and e^2 is inversely proportional to $\alpha\beta$, in the first approximation; if α and β (and perhaps some independent small corrections also) are constant, $\hbar$ and e^2 are constant in all approximations. If the centimeter, second, or gram is differently defined, but still in the same sort of atomic manner, the behavior of c, $\hbar$, and e^2 can be quite different, but their values will still be predictable in terms of α and β, and will be constant in all approximations if α and β are. It is thus not permissible to make any arbitrary assumptions about them. Since the definitions are arbitrary, the behavior of c, $\hbar$, and e^2, though predictable, is secondary; the fundamental quantities are the dimensionless ones. (auth)

36751 MASS-SPECTROMETRIC INVESTIGATION OF SECONDARY EMISSION FROM ALLOYS. Schelten, Jakob (Univ., Mainz). Z. Naturforsch., 23a: 109-13(Jan. 1968). (In German).

An alloy bombarded with 12-keV Ar^+ ions emits singly charged secondary ions (SI) of all components of the target. By measuring the SI currents in a mass spectrometer a quantitative analysis is possible (Ion-bombardment ion source). The SI emission of aluminum and iron alloys with varying concentration of other components is investigated. It is shown that the relative SI yield, i.e., the ratio of the SI yield of the extra components to the yield of the main components aluminum and iron, respectively, is independent of the composition of the sample provided that the sample contains more than 90% of the main component. This result is in qualitative agreement with the Langmuir–Saha equation. (auth)

36752 PHOTOIONIZATION STUDIES WITH ATOMIC BEAMS. III. IONIZATION CROSS SECTION OF ATOMIC NITROGEN. Comes, F. J.; Elzer, A. (Univ., Bonn). Z. Naturforsch., 23a: 133-6(Jan. 1968). (In German).

The photoionization cross section of atomic nitrogen was measured between the ionization limit and 432 Å. The experimental values are well fitted by those from a calculation of Henry due to the dipole velocity approximation. A Rydberg series converging to the ^5S state of the ion is clearly identified from the ionization measurements and is shown to ionize. (auth)

36753 PHOTOIONIZATION STUDIES WITH ATOMIC BEAMS. II. IONIZATION CROSS SECTION OF ATOMIC OXYGEN. Comes, F. J.; Speier, F.; Elzer, A. (Univ., Bonn). Z. Naturforsch., 23a: 125-33(Jan. 1968). (In German).

An experiment to determine the absolute value of the photoionization cross section of atomic oxygen is described. The atoms are produced in an electrical discharge in oxygen gas with 1% hydrogen added. In order to prevent recombination a crossed beam technique is employed. The ions formed are detected by a time-of-flight mass spectrometer. The concentration of oxygen atoms in the beam is 57%. The measured photoionization cross section of atomic oxygen is compared with theoretical data. The results show the participation of autoionization processes in ionization. The cross section at the autoionizing levels detected is considerably higher than the absorption due to the unperturbed continuum. Except for wavelengths where autoionization occurs the measured ionization cross section is in fair agreement with theory. This holds up to 550 Å whereas for shorter wavelengths the theoretical values are much higher. (auth)

36754 PHOTOIONIZATION STUDIES WITH ATOMIC BEAMS. I. MEASUREMENT OF PHOTOYIELDS BY MEANS OF THE PHOTOIONIZATION OF HYDROGEN ATOMS. Comes, F. J.; Elzer, A.; Speier, F. (Univ., Bonn). Z. Naturforsch., 23a: 114-24(Jan. 1968). (In German).

The crossed beam technique is for the first time used in a mass spectrometric investigation of photoionization products. The photoionization threshold of atomic hydrogen is 911 Å and its photoionization cross section is exactly calculable. This allows the amount of ionization to be calculated, if the intensity of the radiation and the particle density are known. On the other hand, an unknown photon flux can be determined from the measured proton current. With the new technique the absolute photoelectric yield and/or the photoionization cross section of gases can be measured. The experimental device consists essentially of a uv monochromator, a hydrogen atomic beam, and a mass spectrometer. By the atomic beam technique it is also possible to measure the photoionization cross section of unstable particles such as atomic oxygen and atomic nitrogen. (auth)

36755 AUTOIONIZATION IN ATOMIC SPECTRA. Comes, F. J.; Saelzer, H. G.; Schumpe, G. (Univ., Bonn). Z. Naturforsch., 23a: 137-51(Jan. 1968). (In German).

A detailed discussion of the phenomenon of autoionization and its influence on the absorption spectra of atomic gases is given. Some consideration is devoted to the calculation of cross sections. This theory is applied to the autoionizing Rydberg levels lying above the $^2P_{\frac{1}{2}}$ threshold of the rare gases krypton and xenon. A numerical calculation is described which allows the important parameters of Rydberg series to be calculated. These parameters are the so-called unperturbed continuum, the lifetime and oscillator strength of the autoionizing states, the line shape parameter and the quantum defect. From absorption measurements in argon and krypton considerations follow concerning the behavior of these terms at threshold. A further result of the calculations is the transition probability into the ionic states $^2P_{\frac{1}{2}}$ and $^2P_{\frac{3}{2}}$ at the $^2P_{\frac{1}{2}}$ limit. These values are compared with measured intensities of photoelectrons from a retarding potential experiment. (auth)

Cosmic Radiation

Refer also to abstracts 36044, 36590, and 36692–36694.

36756 (BNWL-SA-1741) SHORT LIVED COSMIC RAY PRODUCED RADIONUCLIDES AS TRACERS OF ATMOSPHERIC PROCESSES. Young, James A.; Wogman, Ned A.; Thomas, Charles W.; Perkins, Richard W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1, 1968. Contract AT(45-1)-1830. 21p. (CONF-680308-10). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

Measurements of radionuclide concentrations in both air and rain water are described. Their use in describing atmospheric mixing and precipitation processes is discussed. (M.O.W.)

36757 (N–68-10507) MEASUREMENT AND INTERPRETATION OF THE ISOTOPIC COMPOSITION OF HYDROGEN AND HELIUM COSMIC-RAY NUCLEI BELOW 75-MeV/NUCLEON. Meyer, J. P.; Hagge, Donald E.; McDonald, Frank B. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Aug. 1967. 18p. (NASA-TM-X-63015; X–611-67-401). CFSTI.

Measurements of the hydrogen ($\Gamma_d \approx d/^1H$) and helium ($\Gamma_{He} \approx {}^3He/{}^4He$) isotopic abundance ratios were made by the IMP-III and OGO-I satellites outside the Earth's atmosphere and magnetosphere. The results show a very steep positive slope for Γ_d between 20 and 50 MeV/n; Γ_{He} has a positive slope between 30 and 90 MeV/n. Propagation calculations were undertaken to study the bearing of different source and propagation models on Γ_{He} and on Γ_d which is not affected by the solar modulation. A Monte Carlo technique was used to propagate the cosmic-ray protons and ^4He nuclei from the source to the Earth. Available cross-section data were surveyed. Ionization loss, energy dependence of the cross sections, and reaction kinematics were considered. The results are considered to completely rule out a total energy, and favor a kinetic energy source power spectrum. (STAR)

36758 (N–68-22425) COSMIC RAY DEUTERIUM AND ^3He OF SECONDARY ORIGIN AND THE RESIDUAL MODULATION OF COSMIC RAYS. Ramaty, Reuven; Lingenfelter, Richard E. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1968. 55p. (NASA-TM-X-63178; X–611-68-144). CFSTI.

Assuming that cosmic deuterons and ^3He nuclei are of secondary origin, it is shown that a unique determination of both the cosmic-ray path length and the residual interplanetary field modulation of solar minimum may be made from a comparison of the calculated and measured intensities of these two nuclei. The production of deuterium and ^3He by cosmic-ray interactions in the Galaxy is calculated, considering energy-dependent cross-sections, interaction kinematics, and demodulated cosmic-ray spectra. The resulting flux at the Earth is obtained by taking into account leakage from the Galaxy, ionization losses, nuclear breakup, and modulation. From a comparison of these calculations with the measured deuterium and H intensities at the Earth, it is concluded that all the data can be understood in terms of an energy-independent cosmic-ray path length and a residual interplanetary field modulation at solar minimum. (auth) (STAR)

36759 (N–68-22925) EQUILIBRIUM SPECTRA OF SECONDARY COSMIC-RAY POSITRONS IN THE GALAXY AND THE SPECTRUM OF COSMIC-GAMMA-RAYS RESULTING FROM THEIR ANNIHILATION. Stecker, F. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1968. 45p. (NASA-TM-X-63187; X–640-68-135). CFSTI.

A general formula is derived for calculating the gamma spectrum resulting from the annihilation of cosmic-ray positrons. This formula is used to calculate annihilation gamma spectra from various equilibrium spectra of secondary galactic positrons. These spectra are then compared with the gamma spectra produced by other astrophysical processes. Particular attention is paid to the form of the gamma spectrum resulting from the annihilation of positrons below 5 keV. It is found that for mean leakage times out of the Galaxy of less than 400 million years, most of the positrons annihilating near rest come from the beta decay of unstable nuclei produced in cosmic-ray $p-C^{12}$, $p-N^{14}$, and $p-O^{16}$ interactions, rather than from π-meson decay. It is further found that the large majority of these positrons will annihilate from an S state of positronium and that $^3/_4$ of these will produce a three-photon annihilation continuum rather than the two-photon line spectrum at 0.51 MeV. Results of numerical calculations of the gamma fluxes from these processes are given. (auth) (STAR)

36760 (UCRL–18149) SOME HIGH ALTITUDE COSMIC RAY EXPERIMENTS USING A SMALL SUPERCONDUCTING MAGNET. Anderson, Jared A.; Eandi, Richard; Golden, Robert L.; Hagge, Donald E.; Kurz, Richard (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1968. Contract W-7405-eng-48. 18p. Dep. CFSTI.

Two experiments of astrophysical importance are suggested: the determination of the cosmic-ray electron energy spectrum

between 10 and 100 GeV and the measurement of the charge composition of cosmic rays in a similar energy region. Both experiments would utilize magnetic momentum analysis, using a small superconducting magnet suitable for balloon flights to high altitudes. (auth)

36761 APPARATUS FOR THE ROCKET EXPERIMENT ESRO/R-73 OF THE BOLOGNA GROUP. Brini, Domenico; Ciriegi, Umberto; Fuligni, Franco (Univ., Bologna, CNR, Bologna). Ric. Sci., 38: 9-16(Jan. 1968).

A general description of the apparatus for rocket experiment on the cosmic x-ray intensity in the energy range from about 30 to 200 keV is given. Preliminary and final tests are reported together with the procedures and results of the x-ray detector calibrations. (auth)

36762 ACCELERATION OF COSMIC RAYS AT THE SOLAR-WIND BOUNDARY. Jokipii, J. R. (Univ. of Chicago). Astrophys. J., 152: 799-808(June 1968).

The acceleration of fast charged particles by outward-moving magnetic irregularities at the solar-wind boundary is examined. If the particle motion beyond the boundary can be described as diffusion with mean free path λ, this acceleration is important if λ is <O(1 AU). On the other hand, if the magnetic field beyond the boundary is smooth enough that λ is greater than 1 AU, then this acceleration produces a negligible effect. It is concluded that no observational or theoretical arguments preclude $\lambda < O$ (1 AU) beyond the solar-wind boundary, particularly for low-energy particles with energies $\lesssim 1$ GeV. The possible acceleration of low-energy solar cosmic rays is indicated. Acceleration by the solar wind must be regarded as a potential "local" source of cosmic rays which have passed through zero grams of matter since being accelerated. This effect may help explain recent observations of low-energy "galactic" cosmic rays which suggest more than one source for these particles. (auth)

36763 BACKSCATTER AND DIFFUSION OF COSMIC RAYS IN A RANDOM MAGNETIC FIELD. Jokipii, J. R. (Univ. of Chicago). Astrophys. J., 152: 997-1003(June 1968).

The "backscatter" time τ_b (or characteristic pitch-angle relaxation time) and the parallel diffusion coefficient D_{zz} (or diffusion mean free path $\lambda_D = 3D_{zz}/V$) for fast charged particles in an irregular magnetic field are not simply related. Because the net particle deflection is the accumulation of many small deflections, τ_b depends critically on the variation of the scattering rate with pitch angle, whereas λ_D depends on an average scattering. The theory of cosmic-ray transport developed previously suggests that if V is the particle velocity, $\lambda_D \ll \tau_b V$ in certain cases of interest. This is in contrast to ordinary kinetic theory involving large angle scattering, where $\lambda_D = O(\tau_b V)$. The effect is discussed in the context of recent observations of solar cosmic rays which indicate anomalously long backscatter times; observation and theory are in qualitative agreement. (auth)

36764 THE PRIMARY COSMIC-RAY ELECTRON SPECTRUM BETWEEN 0.09 AND 8.4 GeV IN 1965. Fanselow, J. L. (Univ. of Chicago). Astrophys. J., 152: 783-98(June 1968).

The shape of the primary cosmic-ray electron-energy spectrum below 10 BeV provides a constraint for the models of propagation of cosmic-ray particles in the Galaxy and in the Solar System. In an effort to provide independent evidence on this spectrum measurements were made with a magnet–spark-chamber energy spectrometer over the range from 90 MeV to 8.4 BeV. The instrument, flown on a high-altitude balloon on August 5, 1965, from Fort Churchill, Manitoba, allowed the determination of particle rigidity by a deflection measurement, and visual identification of electrons through their cascade shower in a heavy-plate spark chamber. A gas Cherenkov counter in the triggering telescope, as well as the visual identification, efficiently suppressed background due to other particles. Fluxes of 410, 56, 41, 28, 7.2, and 1.6 electrons m^{-2} sec^{-1} $sterad^{-1}$ BeV^{-1} were measured in energy intervals centered at 0.122, 0.28, 0.63, 1.23, 2.70, and 6.0 BeV, respectively. Above 8.4 BeV an integral flux of 2.5 electrons m^{-2} sec^{-1} $sterad^{-1}$ was observed. These results are generally in good agreement, especially above 1 BeV, with measurements near the minimum of solar activity which have been reported by other investigators. However, in the interval at 0.28 BeV the primary flux measured in this experiment is lower than the results of other authors by a factor of 3 to 5. (auth)

36765 HYDROMAGNETIC WAVES EXCITED BY SLOWLY STREAMING COSMIC RAYS. Wentzel, Donat G. (Univ. of Maryland, College Park). Astrophys. J., 152: 987-96(June 1968).

Cosmic rays streaming along a magnetic field generate hydromagnetic waves with a wide range in θ, the angle between the field and the direction of wave propagation. An expansion in terms of $v_A/(c \cos\theta) \ll 1$, where v_A is the Alfvén speed, is used to show that such waves are not influenced by mixing with electrostatic wave modes and that they are generated when the mean velocity of the cosmic rays exceeds (approximately) $v_A/\cos\theta$. The growth rate of the unstable waves is greater than the rate at which cosmic rays escape the galactic disk. (auth)

36766 POSITION OF THE COSMIC EQUATOR IN THE ZERO MERIDIAN REGION. Dubinsky, Juraj (Safarik Univ., Kosice, Czech.); Chaloupka, Pavel; Kowalski, Tadeusz. Mat.-Fyz. Cas., Slov. Akad. Vied, 16: 303-8(1966). (In Czech).

Measurements in May 1963, with a wide-angle counter telescope of the position of the cosmic-ray equator near the zero meridian, were conducted on the ship "Ob" during a cruise from Antarctica to North Cape. Within experimental error, the results agree well with the results of Simpson et al., of 1956 and other available results. It is believed that the disturbances in the Earth's outer magnetic field, caused by the solar wind, have no substantial effect on the cosmic-ray trajectory. (Meteorol. Geoastrophys. Abstr.)

36767 SINGLY AND DOUBLY CHARGED PARTICLES IN THE PRIMARY COSMIC RADIATION. Freier, P. S.; Waddington, C. J. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 73: 4261-71(July 1, 1968).

The final results of the observations made on electrons, protons, deuterons, and helium nuclei of the primary cosmic radiation, using nuclear emulsions exposed in 1963, 1964, and 1965, are presented. Results are given for the intensities and energy spectra of each of these types of particles. (auth)

36768 FLUX OF PRIMARY HELIUM NUCLEI NEAR HYDERABAD DURING 1965. Puri, R. K.; Aditya, P. K. (Indian Inst. of Tech., Delhi). J. Geophys. Res., 73: 4393-5(July 1, 1968).

Nuclear emulsions exposed to cosmic radiation over Hyderabad ($\lambda \simeq 7.6°N$) at an atmospheric depth of 3.8 g/cm^2 for 0830 hours on March 6, 1965, were used to estimate the flux of helium nuclei. These measurements yield the flux at the top of the atmosphere equal to (14.8 ± 1.3) particles/m^2 sec ster; this corresponds to vertical cutoff rigidity equal to 16.7 BV. The value, within experimental errors, agrees with the best flux value obtained at this latitude in 1963, whereas the earlier observations at this latitude seem to overestimate the flux of the helium component. (W.D.M.)

36769 DAILY VARIATION OF THE ASYMPTOTIC DIRECTIONS OF COSMIC RAYS. Gall, Ruth (Univ. Nacional Autonoma, Mexico City. Comision Nacional de Energia Nuclear, Mexico City). J. Geophys. Res., 73: 4400-3(July 1, 1968).

In this letter a computation of asymptotic directions in the model field of Williams and Mead is reported. It is found that the deviation of the asymptotic directions from those for the internal field alone is strongly affected by the current in the neutral sheet of the magnetotail. (W.D.M.)

36770 SEARCH FOR LUNAR EFFECT ON COSMIC RAYS. Bussian, A. E.; Gupta, J. C. (High Altitude Observatory, Boulder, Colo.). J. Geophys. Res., 73: 4404-8(July 1, 1968).

Using modern numerical filtering techniques and the Tukey power spectrum method, a search was made for a lunar effect in neutron monitor, ionization chamber, and meson telescope data from a number of stations. From the results there is little support for a lunar effect on cosmic radiation. (W.D.M.)

36771 TRACER STUDIES OF ATMOSPHERIC EXCHANGE BASED ON MEASUREMENTS OF COSMIC-RAY-PRODUCED ^{22}Na. Roedel, W. (Univ., Heidelberg). Z. Naturforsch., 23a: 51-5(Jan. 1968).

The possibility of estimating the exchange between stratosphere and troposphere is discussed by using only ground level measurements of radioactivity of medium- or long-lived cosmic ray produced nuclides. (M.O.W.)

36772 PROTON AND HELIUM NUCLEI COSMIC-RAY SPECTRA AND MODULATIONS BETWEEN 100 AND 2000 MeV/NUCLEON. Ormes, J. F.; Webber, W. R. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 73: 4231-45(July 1, 1968).

During the years 1963 through 1966, as the Sun passed through its period of minimum activity, an extensive series of balloon flights was conducted to study the primary cosmic radiation and its time variations. The instrument used was a Cherenkov-scintillation counter telescope, the most recent version of which contains two dE/dX detectors, a combination Cherenkov and scintillation detector and a range scintillator. This telescope and its response characteristics to protons and helium nuclei are described. Convolution techniques are used to unfold the Landau fluctuations in energy loss, thereby allowing derivation of the differential energy spectrum from 100 MeV/nucleon up to 2 GeV/nucleon. The differential energy spectra derived by this technique are presented from five balloon flights at Fort Churchill, Canada. The spectra

are found to be in generally good agreement with those of other workers but significantly more accurate. The data are examined to determine the functional form of the 11-year solar modulation by comparing the sunspot minimum spectrum obtained in 1965 with the pre-sunspot minimum spectrum obtained in 1963 and the post-sunspot minimum spectrum obtained in 1966. The modulation data do not follow a functional form of either $1/\beta$ or $1/\beta R$ but rather a form more nearly like $1/\beta R^{\frac{1}{2}}$ between 0.4- and 4-GV rigidity. A theoretical picture is considered in which this behavior can be ascribed to the statistical distribution of magnetic scattering center sizes in the interplanetary medium. In this model the exponent of the rigidity dependent term in the modulation can be related to the slope of the power spectrum of magnetic scattering centers. The data are compared with those of other workers and are found to be consistent with a picture in which the form of the modulation above 200 MeV/nucleon changes from $1/\beta R^{\frac{1}{2}}$ near sunspot minimum to almost $1/\beta R$ near sunspot maximum. It also appears that, at all levels of solar modulation, there is a rigidity below which the form of the modulation becomes $\simeq 1/\beta$. The rigidity below which the form $1/\beta$ holds varies systematically during the solar cycle but differently for protons and helium nuclei in a manner that is difficult to understand within the framework of the current models. (auth)

36773 SOLAR MODULATION OF GALACTIC COSMIC RAYS AND ITS EFFECT ON METEORITES. Shen, C. S.; White, R. K. (Purdue Univ., Lafayette, Ind.). J. Geophys. Res., 73: 4273-80(July 1, 1968).

It is suggested that the magnitude of the effect of solar modulation on galactic cosmic rays can be directly measured through the composition changes in the surface layers of meteorites, which have been exposed to cosmic rays devoid of the greatest part of the modulation. The accumulation rate due to ionization stopping of low-energy galactic cosmic-ray particles in the meteorite is calculated as a function of penetration distance, from 1 to 5 cm, by using a demodulated energy spectrum $I(E) = I_e(E) \exp(\eta/P\beta)$ where P and β are the rigidity and velocity (divided by c) of the particles, $I_e(E)$ is the cosmic-ray flux observed near Earth at solar minimum, and η is the modulation parameter. The accumulation rate, especially of light elements, is a sensitive function of η. For example, at 2-cm depth in a stone meteorite, dN/dt for ^3He is 5×10^{13} particles/cm^3 10^9 years if $\eta = 0.8$ bv as compared to 2×10^{12} particles/cm^3 10^9 years if $\eta = 0$. Therefore, a good determination of η can be obtained by comparing the near-surface isotope changes due to accumulation of ionization-stopped nuclei with the more permeating changes due to spallation. This spallation is caused by the more energetic cosmic-ray particles, for which the solar modulation causes negligible intensity change. (auth)

Direct Energy Conversion

Refer also to abstract 35879.

36774 (ANL-7450, pp 90-104) ENERGY CONVERSION. (Argonne National Lab., Ill.).

Research on new high-specific-power, high-specific-energy cells included emf measurements on the Li-Te system at 660 to 840°K. The LiF-LiCl-LiI eutectic was used as electrolyte. Voltage-current density and capacity curves were measured for Li/Te and Li/Se secondary cells. Measurements were also made on a Li/Te cell with paste electrolyte, and estimated performances of Li/Te and Li/Se batteries with liquid or paste electrolytes are given. As part of the spectroscopic studies of intermetallic systems, Raman spectra of 60 mole % HgI_2-KI and fused $MgCl_2$-2 KCl were measured. The Raman spectrum of ZnSe was also measured at 15,000 atm, and the effects of 30 and 60 kbar pressure on the infrared spectrum of Li_2Se were determined. The thermodynamics of the Na-Pb system were studied by measuring the vapor-liquid equilibria and using the quasi-ideal solution model to calculate the activity coefficients and the equilibrium constants for the formation of NaPb, Na_3Pb, and $NaPb_3$. The correlation between the melting point and stability is pointed out. (D.L.C.)

36775 (CONF-680508-4) THEORY OF THERMIONIC CONVERTER OPERATION WITH APPLICATIONS TO THERMIONIC REACTOR ANALYSIS. Wilkins, D. R.; Sawyer, C. C.; Hill, P. R. (General Electric Co., Pleasanton, Calif. Nuclear Thermionic Power Operation). [1966]. 14p. Dep. CFSTI.

From 2nd International Conference on Thermionic Electrical Power Generation, Stresa, Italy.

Fundamental principles of molecular chemistry, statistical mechanics, and plasma physics are used to derive theoretical output current and efficiency characteristics of vapor thermionic converters. The results are obtained in terms of basic physical parameters which describe the converter electrodes and inter-electrode gas and are in good agreement with corresponding experimental measurements for a broad range of converter operating conditions. The theoretical formalism is employed to study the thermal and electrical performance characteristics of a nuclear thermionic fuel element. It is shown that, with realistic axial fission profiles, fuel void fractions, and temperature limits, over-all fuel element efficiencies in the vicinity of 12 to 14% can be achieved. (auth)

36776 (N-68-15766) SIX-CONVERTER SOLAR THERMIONIC GENERATOR (JG-4). Quarterly Progress Report, July 1-December 15, 1967. Shefsiek, P. K.; Athanis, T.; Lazaridis, L. (Thermo Electron Engineering Corp., Waltham, Mass.). Contracts NAS7-100; JPL-951770. 57p. (NASA-CR-92586; TE-4073-70-68; QPR-2). CFSTI.

For Jet Propulsion Lab., Pasedena, Calif.

During this reporting period the complete design of the JG-4 generator was finalized, six converters were fabricated and tested, and all generator components were fabricated. Also, the components for six other converters were fabricated and processed. (auth) (STAR)

36777 (N-68-16074) SOLAR THERMIONIC GENERATOR DEVELOPMENT. Quarterly Report, September 1-November 30, 1967. (Thermo Electron Engineering Corp., Waltham, Mass.). Dec. 1967. Contracts NAS7-100; JPL-951263. 45p. (NASA-CR-92520; TE-4055-83-68; QR-8). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Progress is reported on: (1) testing of converter T-207 using the S type of filament as the electron bombardment source, (2) fabrication of converter T-208, and (3) selection of a multiconverter generator configuration and calculation of its electrical performance for earth test and cislunar operation. Detailed test results are shown in both graphical and tabular form. (STAR)

36778 (N-68-22991) SOLAR THERMIONIC GENERATOR DEVELOPMENT. Quarterly Report, December 1, 1967-February 29, 1968. (Thermo Electron Engineering Corp., Waltham, Mass.). Apr. 1968. Contracts NAS7-100; JPL-951263. 35p. (NASA-CR-94402; TE-4055-145-68; QR-9). CFSTI.

Fabrication and testing of converter T-208 have been completed. This model is the first under this program to incorporate a collector-radiator heat pipe structure. The dynamic performance of converter was almost identical to that of model T-207 in spite of a 17% reduction in collector area, but the failure of the static data to reproduce the performance data obtained dynamically has shown that the collector of converter T-208 operates at an excessive temperature. The cause of the high collector temperature is believed to be the limited area for vapor flow available at one component of the heat pipe, and it will be corrected in the construction of the following model. In addition, the performance of converter T-208 was relatively low, and cesium conduction tests revealed an unusually large spacing of about 4.4 mils; steps will be taken to improve the positioning of parts during assembly of T-209. (auth) (STAR)

36779 A DUCT WALL OF AN MHD GENERATOR. (to Compagnie Generale d'Electricite). British Patent 1,115,394. May 29, 1968. Priority date Mar. 2, 1965, France.

A duct wall of an MHD generator is described which includes an assembly of spaced metallic, prismatic elements disposed so that an end face of each element forms part of the inner surface of the wall. A refractory material fills the gaps between the elements at the inner surface of the wall to complete this inner wall surface. Elastomeric silicone which has a Shore hardness coefficient of between 40 and 90, fills the gaps between the elements in two zones behind the refractory material. The silicone adheres to the side faces of the elements to form fluid tight joints and to hold these elements in a fixed position. The zones are spaced so that the silicone defines coolant circulation channels with these faces which are substantially rectilinear. Further details of the duct wall construction and the method of manufacturing it are included. (M.H.R.)

36780 IMPROVEMENTS IN AND RELATING TO MAGNETOHYDRODYNAMIC ELECTRIC GENERATORS. (to Kabushiki Kaisha Hitachi Seisakusho). British Patent 1,114,715. May 22, 1968. Priority date May 6, 1964, Japan.

A magnetohydrodynamic electric generating apparatus is described which includes inner and outer electrode means disposed one inside the other, means for passing an ionized working fluid along an annular flow passage between said electrode means, and an excitation means. The excitation means includes an electrically conductive element extending within said inner electrode means for establishing a circumferentially directed magnetic field in said flow passage, whereby an electromotive force is induced between said electrode means. (M.H.R.)

36781 COMPOSITE ELECTRODE FOR MAGNETOHYDRODYNAMIC GENERATOR. Yerouchalmi, David (to Commissariat a l'Energie Atomique). British Patent 1,113,839. May 15, 1968. Priority date May 25, 1965, France.

A composite electrode suited for use in the channel of an MHD converter is described. The electrode includes a first conductive zone and a second zone constituted by a thermally and electrically conductive metal box cooled by an internal flow of water. This box is separated from the first zone by a bonding layer and is fitted with metallic members at the top portion thereof so as to provide a mechanical connection and an electric relay between the two zones. (M.H.R.)

36782 LIQUID METAL PISTON MHD GENERATOR. Palmer, J. P. (to United States Atomic Energy Commission). U. S. Patent 3,376,440. Apr. 2, 1968.

A liquid metal piston magnetohydrodynamic (MHD) generator is described in which metal vapor (i.e., potassium) generated in a reactor is utilized to reciprocate a liquid metal piston of the same metal in a magnetic field. Electrodes tap the electric energy produced from the cutting of lines of force. (AEC)

36783 ELECTRODE AND METHOD OF FABRICATION. Bouillon, Bernard; Yerouchalmi, David; d'Albis, Antoine (to Commissariat a l'Energie Atomique). British Patent 1,114,368. May 22, 1968. Priority date May 25, 1965, France.

An electrode designed for operation in the channel of an MHD converter is described. The electrode is characterized in that it is constituted by a laminated ceramic plate. The top layer of the plate is formed of a stabilized refractory oxide while the following layers of the plate are formed in turn of the same oxide which is enriched to a progressively increasing extent with a second refractory oxide. The proportions of enrichment are such that the conductivity of the bottom layer at its working temperature is equal to the conductivity of the top layer at its working temperature. The method of fabrication of such an electrode and the materials used are included. (M.H.R.)

36784 THERMIONIC CONVERTER. Busse, Claus-Adolf; Caron, Rene; Grover, George Maurice (to European Atomic Energy Community). British Patent 1,115,799. May 29, 1968. Priority date Dec. 14, 1964, Germany.

A thermionic converter is described in which a heat pipe is employed to convey heat to the emitter electrode or to remove heat from the collector electrode. A heat pipe is a heat transfer device comprising a container, condensable vapor, and capillary means disposed within the container. This means is capable of causing by capillary action the transport of the condensed vapor from a cooler zone of the container to a hotter zone. Lithium or silver is employed as the condensable vapor. (M.H.R.)

36785 MAGNETOHYDRODYNAMIC GENERATION OF ALTERNATING CURRENT. (to North American Aviation, Inc.). British Patent 1,114,967. May 22, 1968. Priority date Nov. 4, 1965, United States.

A method of generating alternating electric current is described which includes the steps of forming slugs of a substantially electrically conductive fluid having a magnetic Reynolds number greater than unity in a substantially electrically nonconductive steady-flow working fluid. A predetermined magnetic dipole characteristic is impressed on each of the slugs so that periodic ones of these slugs have like magnetic polarity. Alternating current is extracted from the spaced dipole slugs. The ac MHD generator system includes a source of substantially electrically non-conductive working fluid which flows adjacent to a stator winding means. An exciter means is positioned between the source and the stator winding means to selectively impress a predetermined dipole characteristic substantially through the working fluid. Injection means are positioned between the source and the stator winding means for injecting a predetermined volume of liquid into the working fluid at intervals so as to form the slugs. Control means are provided for sequentially actuating the exciter means and the injector means. (M.H.R.)

36786 SEEDED CESIUM PLASMA DIODES AND THE PENNING EFFECT. Kaufman, Allen. Philadelphia, Univ. of Pennsylvania, 1967. 223p.

Thesis.

A theoretical investigation was made of the effects of seeding a cesium plasma diode with mercury or cadmium without the presence of an external light source. A macroscopic phenomenological model based on the principles of conservation of mass, current, and energy was developed for the diode. The positive-sheath motion diagram was used for the ignited mode while the negative sheath motive diagram was used for the unignited mode. The electron density–electron temperature relationship of the plasma was calculated using rate equations. A nine-level atomic model was used for cesium; a four level atomic model was used for mercury or cadmium. It was found that when the diode is seeded with a one hundred to one ratio of cadmium to cesium, the electron density of the plasma can be increased by as much as a factor of sixty over the electron density in a pure cesium plasma at the same electron temperature. The addition of mercury to the plasma was found to result in little change in the electron density–electron temperature relationship of the plasma. This is attributed to the fact that the excitation energy of mercury is much larger than the ionization energy of cesium. Using the electron density–electron temperature relationship and the model for the diode, the following results were obtained for the unignited mode. Seeding the diode with cadmium resulted in the diode operating at a higher electron density and a lower electron temperature. It was found that the change in the output current was proportional to the change in the electron density when the spacing was smaller than the mean free path. The output current was found to increase by as much as a factor of four when the diode was seeded with cadmium to cesium ratio of one hundred to one. When the diode was seeded with mercury the output current in the unignited mode decreased. In the case of the ignited mode it was found that mercury results in no enhancement in the performance of the diode. The addition of cadmium resulted in the diode operating at a lower electron temperature and a higher electron density. It was found that the electron density did not increase by more than a factor of one at the maximum power point. It was also shown that the change in the output current is more than an order of magnitude less than the change in the electron density and thus negligible. The change in the output voltage at the maximum power point increases by no more than 4% even for a cadmium-to-cesium ratio of one hundred to one. The gain in the maximum power is no more than 5 or 6%. Mercury will result in no enhancement in the performance of the diode. Seeding with cadmium will result in an enhancement in the unignited mode. Seeding with cadmium will result in no significant enhancement in the ignited mode. Since the region of interest in practical thermionic diodes is the ignited mode, seeding with mercury or cadmium is of little engineering significance. (TSS) (Disser. Abstr.)

Fluid Physics

36787 STABILITY OF A HORIZONTAL FLUID INTERFACE IN A PERIODIC VERTICAL ELECTRIC FIELD. Yih, Chia-shun (Univ. of Michigan, Ann Arbor). Phys. Fluids, 11: 1447-9 (July 1968).

The stability of the interface in the presence of a periodic electric field is considered. It is shown that the stability is governed by a Mathieu equation, that the interface can be unstable even if the electric field is at all times weaker than that needed for instability in the case of a steady field, and that, when instability occurs, the waves may either be synchronous with the electric field, or have twice its frequency. (auth)

36788 ANALYSIS OF CONFINED MAGNETOHYDRODYNAMIC VORTEX FLOWS. Loper, David E.; Ostrach, Simon (Case Inst. of Tech., Cleveland). Phys. Fluids, 11: 1450-65(July 1968).

The vortex flow of a viscous, incompressible, and electrically conducting fluid confined between two finite flat plates (with a net radial mass flow) in the presence of an applied axial magnetic field is considered. The details of the velocity field including boundary-layer thickness and redistribution of radial mass flow are of primary concern. The analysis is limited to the case of the separation distance between the two end plates being small compared with the radius of the plates; this allows the momentum equations to be uncoupled from the electromagnetic equations. The momentum equations are linearized and solved for the velocities and the pressure as Fourier series. It is found that magnetic effects tend to decrease the boundary-layer thickness by a small percentage and tend to decrease substantially the mass flow drawn into the boundary layers. (auth)

36789 FINITE-MAGNETIC-REYNOLDS-NUMBER EFFECTS IN MAGNETOGASDYNAMIC FLOWS. Tang, J. Y. T.; Seebass, R. (Cornell Univ., Ithaca, N. Y.). Quart. Appl. Math., 26: 131-46(Apr. 1968).

In this investigation of magnetohydrodynamic flow, an aligned-fields analysis for compressible fluids flow is reported. These flows exhibit such phenomena as forward-facing waves and upstream wakes. It is required that the body be slender enough so that it is possible to linearize the governing equations about a uniform state. To analyze this set of equations without further simplifications would be formidable. An important simplification was to treat the case of large magnetic Reynolds number, i.e., large electrical conductivity. With this assumption, a procedure using Fourier synthesis could be utilized. The quantitative results obtained verified the qualitative predictions of Sears and Resler con-

cerning the behavior of flows past finite bodies, based on the knowledge of the solutions for flow over infinite sinusoidal walls. Furthermore, they serve to indicate the possibility of observing experimentally the unusual phenomena of forward-facing waves and upstream wakes. After writing equations pertinent to this problem, and linearizing them about the uniform conditions at infinity, a single linear equation was obtained for the transverse component of the perturbation velocity, which in turn led to an algebraic equation (the dispersion equation) satisfied by each of the field modes. The general form of the solution was then written as an arbitrary combination of all these modes. With the assumption of large magnetic Reynolds number, it was possible to express the solution in a tractable form, and to discuss its composition in terms of well-known phenomena. (BBB)

36790 SHOCK WAVES AND COMPRESSIBILITY HYPOTHESES IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Lichnerowicz, Andre. Compt. Rend., Ser. A and B, 266: 888-93(Apr. 22, 1968). (In French).

The Σ shock waves of magnetohydrodynamics, assumed oriented in time, were studied previously (Compt. rend., 260: 44(1965)). It is established in the present study that, under the compressibility hypotheses, Σ must be oriented in time. The velocities of Σ were placed with respect to the magnetosonic and Alfvén velocities. (tr-auth)

Geophysics

36791 (AD-662228) A CINEMATOGRAPHIC DISPLAY OF OBSERVATIONS OF LOW-ENERGY PROTON AND ELECTRON SPECTRA IN THE TERRESTRIAL MAGNETOSPHERE. Report No. 67-67. Frank, L. A.; Shope, W. L. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Nov. 1967. Contract Nonr-1509(06). 27p. CFSTI.

A massive series of observations of the differential energy spectra of proton and electron intensities over the energy range of approximately 300 eV to 50 keV within the earth's magnetosphere and its environs was obtained with an array of electrostatic analyzers borne on OGO 3. In order to supplement the presently existing publications derived from these observations and to provide further insight into the distributions of low-energy charged particles within the radiation zones over geocentric radial distances of approximately 2 to 20 R_E, a SC 4020 microfilm plotter was utilized to construct a cinematographic display of the differential energy spectra of proton and electron intensities which spans a complete circuit of the spacecraft around the Earth, or about 50 hours of substantially continuous observations beginning at 1330 UT on July 14, 1966. This cinematographic display comprises approximately 18,000 individual frames and summarizes some 550,000 intensity measurements. A description of the methods and graphic results is furnished as an aid in interpretation of this visual presentation of the observations. (auth) (USGRDR)

36792 (AD-662579) DIFFUSION PROCESSES INFLUENCED BY CONJUGATE-POINT WAVE PHENOMENA. Cornwall, John M. (Aerospace Corp., El Segundo, Calif.). Sept. 1967. Contract F04695-67-C-0158. 22p. (TR-0158(3260-01)-1; SAMSO-TR-67-67). CFSTI.

Radial diffusion coefficients for low-energy protons in the magnetosphere are estimated for processes involving Pc1, -2, and -3 hydromagnetic waves. These diffusion coefficients are compared to rough estimates of diffusion due to magnetic impulses and bays; this comparison gives an overall diffusion rate. An effective loss rate for pitch-angle diffusion (caused by Pc1) is developed and combined with radial diffusion to yield a nonlinear differential equation. Some estimates of expected proton flux levels are made on the basis of this equation. (auth) (USGRDR)

36793 (AD-663269) MID-LATITUDE VERTICAL TRANSMISSION OF GEOMAGNETIC MICROPULSATIONS THROUGH THE IONOSPHERE. Greifinger, Phyllis S. (RAND Corp., Santa Monica, Calif.). Nov. 1967. Contract DAHC15-67-C-0141. 69p. (RM-5099-ARPA). CFSTI.

The report includes a theoretical description of the transmission of extremely low-frequency (below a few cps) geomagnetic waves propagating vertically through the ionosphere at middle and high latitudes, either naturally or as a result of a nuclear burst. The principal findings of the study are given. (USGRDR)

36794 (AD-664902) STUDIES OF THE EQUATORIAL IONOSPHERE USING TRANSMISSIONS FROM ACTIVE SATELLITES. Final Scientific Report, February 1, 1964–April 20, 1967. Koster, John R. (Ghana Univ., Legon. Dept. of Physics). Sept. 25, 1967. Contract AF 61(052)-800. 94p. (AFCRL-68-0020). CFSTI.

Satellite predictions and orbital calculations are discussed, and Fortran II programs and subprograms found useful for these purposes are given. The azimuthal distribution of irregularities as observed from Legon are found to be uniform. Their accurate field alignment is verified. The height distribution is given and an upper limit to the thickness of the layer found. A further study was made of results obtained from Early Bird in 1965, with results on the probability distribution of the Scintillation Index S, its dependence on time, and the power spectrum of the fading signal. The rate method, the total angle method, a second-order method of analysis of Faraday rotation records, and their applicability to the determination of total electron content as a function of position are discussed. Numerous examples illustrate the diurnal development of the portion of the equatorial anomaly observable from Legon. (auth) (USGRDR)

36795 (AD-665351) IONOSPHERIC RESEARCH. Quarterly Progress Report No. 16 (Final), September 12, 1963–September 30, 1967. Webb, H. D. (Illinois Univ., Urbana. Electrical Engineering Research Lab.). Nov. 1967. Contract DA-36-039-AMC-03703(E). 36p. CFSTI.

Moon-reflected signals at 150.6 MHz were received on 31 days for approximately 273 hours during the period July 1 to September 30, 1967. In addition, signals at 413.25 MHz were received for approximately 52 hours. The 150.6-MHz signals were received on 606 days for 5203 hours from September 12, 1963, to September 30, 1967. The strip charts were read out, and corrected Faraday rotation and total columnar electron content were plotted for all of the days of operation. These results are available in Atlas form for all of the days of operation through 1966. The data for all days of operation in 1967 were machine plotted. Seasonal averages are presented for late 1966 data and for all of the 1967 data through September 1967. These averages indicate the marked increase due to increased solar activity and the lower summertime level. (auth) (USGRDR)

36796 (AD-665407) STUDIES ON A D-REGION MOBILITY SPECTROMETER. Report No. Scientific-315. Kuo, T. J. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Feb. 15, 1968. Contract DAAD05-67-C-0642. 61p. CFSTI.

A theory of mobility spectrometer applicable in the 40 to 70 km altitude range is presented. This theory is an extension of a previous work. The device is entirely based on the continuum concepts, which measures the mobility and abundance of the various constituents. The resolution of this device in mobility is within 1.4%. (auth) (USGRDR)

36797 (AD-665422) BOUNDARY OF ENERGETIC ELECTRONS DURING THE JANUARY 13–14, 1967 MAGNETIC STORM. Report for January–December 1967. Paulikas, George A.; Blake, J. Bernard; Freden, Stanley C.; Imamoto, Sam S. (Aerospace Corp., El Segundo, Calif.). Jan. 1968. Contract F04695-67-C-0158. 26p. (TR-0158(3260-20)-5; SAMSO-TR-68-56). CFSTI.

Measurements of energetic electron fluxes were made aboard the synchronous satellite ATS-1 (1966-110A) during the magnetic storm of January 13–14, 1967. Between 0007 and about 0105 UT (approximately 1400–1500 local time) on January 14, the electron fluxes dropped to background levels in a manner which when associated with the onboard magnetometer data suggests that the boundary of the magnetosphere was compressed to less than 6.6 R_E on the day side of the magnetosphere. (auth) (USGRDR)

36798 (AD-666648) A STUDY OF THE MECHANISMS OF WHISTLER PROPAGATION AND VLF EMISSION GENERATION. Final Report, October 1, 1966–September 30, 1967. Helliwell, Robert A. (Stanford Univ., Calif. Stanford Electronics Labs.). Jan. 1968. 14p. (AFOSR-68-0219). CFSTI.

Extensions to the theory of vlf propagation in the magnetosphere with the effects of ions included have explained dispersion characteristics of magnetospherically reflected (MR) whistlers, a complex phenomenon discovered recently with satellites. Because its dispersion depends on both electron and ion distributions, as well as on the static magnetic field, the MR whistler may be useful as a new tool in the study of the magnetosphere. It was found that the sharp cutoff of ducted whistlers at half the minimum gyrofrequency on the path is often accompanied by whistler amplification and generation of discrete vlf emissions near the cutoff frequency. Satellite data show that ducts are not required for the generation of discrete vlf emissions and that the region of generation most likely lies near the top of the line of force thru the satellite. Observations of artificially stimulated emission on the ground show that their occurrence peaks up when the minimum gyrofrequency is twice the triggering frequency. A new theory is advanced to explain the generation of discrete vlf emissions and is based on cyclotron resonance between electrons in the keV energy range and a longitudinally propagating wave. (USGRDR)

36799 (AD-666671) ROCKET AND SATELLITE TECHNIQUES FOR MEASUREMENT OF ELECTRON DENSITY AND

RELATED IONOSPHERIC PARAMETERS. Final Report, April 1, 1965–March 31, 1967. Burt, David A.; Allred, Glenn D.; Westlund, Clay D. (Utah Univ., Salt Lake City. Upper Air Research Lab.). Dec. 1967. Contract AF19(628)-5044. 94p. (UU-67-9; AFCRL-68-0010). CFSTI.

Normal concentrations of electron density in the ionosphere and changes in these concentrations associated with various disturbances, both natural and man made, have been investigated by a series of eight rocket and satellite payloads. Instruments for measuring fine-scale, long-term deviations and short-term, larger-scale deviations in electron density and other related parameters have been included in each payload. This report details instrumentation and presents brief results of the experiments developed by Upper Air Research Laboratory, University of Utah, for each of the following programs: Aerobee 150 (3.614) D region, gyro-interaction; Four Nike-Hydacs solar eclipse (12 November 1966); OV2-3 Satellite electron density at synchronous orbit altitude; OV3-2 Satellite F-region electron density (polar orbit); Javelin (19.191) F-region irregularities—pulse-phase delay experiment. (auth) (USGRDR)

36800 (AD-666964) CHARGE-EXCHANGE LIFETIMES FOR LOW-ENERGY PROTONS IN THE OUTER RADIATION ZONE AND IMPLICATIONS CONCERNING THE DENSITY OF ATOMIC HYDROGEN IN THE TERRESTRIAL EXOSPHERE. Report No. 68-3. Swisher, R. L.; Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jan. 1968. Contracts Nonr-1509(06); NAS5-2054. 34p. CFSTI.

The directional, differential intensities of protons over the energy range of about 200 eV to 50 keV injected into the outer radiation zone (i.e., the extraterrestrial ring current) coincident with the initial phase of the geomagnetic storm during early July 1966 were monitored with a sensitive array of electrostatic analyzers borne on OGO 3. Proton intensities are greatly enhanced throughout the outer radiation zone for L values approximately ≥ 3 during the main phase of this moderate magnetic storm, and the injection mechanism ceases to be effective after the storm main phase for L values approximately ≤ 5.5. The proton ($30 \leq E \leq 50$ keV) intensities are shown to exponentially decay with lifetimes ranging from 15 to 105 hours in substantial agreement with calculated lifetimes invoking measured charge-exchange cross sections for protons incident upon atomic hydrogen and a model of the atomic hydrogen density in the exosphere. The atomic hydrogen density model for the terrestrial exosphere providing the best fit to the observed proton lifetimes over geocentric radial distances 2.5 to 4.8 R_E (corresponding to observed densities of about 200 to 30 hydrogen atoms/cc) allows only atoms in ballistic orbits in the exosphere as opposed to a model geocorona which includes an additional atomic hydrogen population in captive elliptical orbits. (auth) (USGRDR)

36801 (N-68-10067) SATELLITE OBSERVATIONS OF VLF EMISSIONS AND THEIR ASSOCIATION WITH ENERGETIC CHARGED PARTICLES. Gurnett, Donald A. (State Univ. of Iowa, Iowa City). Sept. 1967. Contract Nonr-1509(06). 31p. (NASA-CR-89967). CFSTI.

A summary of recent satellite observations of vlf emissions and their association with energetic charged particles is presented. Using data from the Injun 3 satellite maps of the broadband intensity of magnetospheric vlf emissions are shown as a function of invariant latitude and magnetic local time. Examples of the simultaneous occurrence of vlf emissions and energetic charged-particle precipitation are discussed. (auth) (STAR)

36802 (N-68-10358) THE RESPONSE OF THE UPPER ATMOSPHERIC TEMPERATURE TO CHANGES IN SOLAR EUV RADIATION AND GEOMAGNETIC ACTIVITY. Chandra, S.; Krishnamurthy, B. V. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Aug. 1967. 22p. (NASA-TM-X-63014; X-615-67-385). CFSTI.

The upper atmospheric neutral temperature derived from satellite drag was analyzed with a view toward determining the relative importance of solar euv and magnetic activity on heating of the upper atmosphere. As indices of solar euv radiation, the radio fluxes obtained from the ground-based observations in the frequency range of 200 to 9400 Mc were used. Also, for the period March 7 to May 15, 1962, a direct comparison was made with the euv flux obtained from the OSO 1 Satellite. As the index of magnetic activity the planetary magnetic index K_p was used. (auth) (STAR)

36803 (N-68-10387) SEMIGROUP SOLUTION OF THE TIME DEPENDENT CONTINUITY EQUATION FOR THE ION DENSITY IN THE IONOSPHERIC F2 LAYER. Kritt, Brian (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). July 1967. 15p. (NASA-TM-X-63013; X-621-67-356). CFSTI.

The continuity equation for the ion density in the F2 region is a valuable tool for studying the structure of this region. However, the theory of semigroups and their perturbations have not been used to obtain solutions for the time-dependent equation. An introduction to the semigroup theory and its application to the continuity equation is presented. The perturbation method is used to solve a particular simple form of the continuity equation so that the analytical details of the method can be carried out. The physical problem which gives rise to the continuity equation is given followed by a discussion of the semigroup theory and its application to partial differential equations of a general type. These considerations are then specialized to obtain the semigroup solution of the continuity equation. (auth) (STAR)

36804 (N-68-10509) THE EARLY EFFECTS OF INCREASING SOLAR ACTIVITY UPON THE TEMPERATURE AND DENSITY OF THE 1000 KILOMETER IONOSPHERE. Brace, L. H.; Mayr, H. G.; Reddy, B. M. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Sept. 1967. 26p. (NASA-TM-X-63019; X-621-67-478). CFSTI.

Observations of electron temperature and concentration at 1000 km were carried out by electrostatic probes on Explorer XXII. Midday and midnight measurements at latitudes of approximately 60°N to 60°S for January 1965, 1966, and 1967 are presented. Comparison of these latitude profiles shows that the daytime electron density at 1000 km increases with solar activity while the electron temperature increases initially but then decreases. The nighttime ionosphere is less affected by the increased solar activity, although N_e decreases somewhat and T_e increases slightly. This behavior can be understood qualitatively in terms of the changing composition and density of the neutral atmosphere, caused by the increase in neutral temperature during increasing solar activity. Of prime importance for the electron temperature is the early escape of neutral hydrogen which reduces the effective local cooling of electrons and permits T_e to rise initially. The higher gas temperatures associated with increased solar activity cause enhancement of the heavier neutral constituents (O, He) which increases the local electron cooling and results in lower electron temperatures. (auth) (STAR)

36805 (N-68-10976) BEHAVIOR OF THE TOPSIDE IONOSPHERE DURING A GREAT MAGNETIC STORM. Bauer, S. J.; Krishnamurthy, B. V. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1967. 29p. (NASA-TM-X-63034; X-615-67-576). CFSTI.

Variations in the electron density distribution of the topside ionosphere (including the height of the F2 peak) obtained from Alouette 1 during the great magnetic storm of April 17–18, 1965, are analyzed. Both enhancement and depletion of topside ionization are observed depending on the phase of the magnetic storm. Specifically, enhancement is associated with the positive phase and the asymmetric part of the main phase, while depletion of the topside ionosphere occurs during the symmetric part of the storm main phase over a latitude range corresponding to L values greater than 3. Associated with this depletion is a redistribution of ionization indicating that the topside ionosphere during the symmetric main phase consists primarily of O^+ (with H^+ being depleted). The enhancement of topside ionization during the positive phase of the storm appears to be associated with the compression of the daytime magnetosphere during that phase of the storm. The depletion seems to be associated with the expansion of field tubes due to the presence of the high energy–density ring current plasma as observed on satellites causing an upward flux from the topside ionosphere. (auth) (STAR)

36806 (N-68-15189) SHOCK AND MAGNETOPAUSE BOUNDARY OBSERVATIONS WITH IMP-2. Binsack, Joseph H. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). June 28, 1967. Contracts NAS5-2952; AT(30-1)-2098. 37p. (NASA-CR-91901). CFSTI.

The magnetopause and bow shock boundaries data obtained from the flight of the IMP-2 satellite are discussed. The boundary crossings during the first twelve orbits of the IMP-2 are catalogued into one of six types, determined by the character of the signals observed before and after the crossing. Plasma experiment data show that the boundaries of the magnetosheath are extremely pliable and responsive to solar and geomagnetic activity. Even during relatively quiet periods, the boundaries appear to remain in motion although on a smaller scale. Rapid varying fluxes in energy and direction are observed to be characteristic of the shock boundary layer. The operations of the plasma detector are reviewed. (STAR)

36807 (N-68-15296) THE MAGNETOSPHERIC RADIATION BELT AND TAIL PLASMA SHEET. Piddington, J. H. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Nov. 1967. 40p. (NASA-CR-92565). CFSTI.

Theories of the origin of the storm-time radiation belt (the ring current) and associated bays and auroras have invoked hydromagnetic flow from the magnetotail on the one hand and flow into the tail on the other. It is shown that both flow patterns occur, the inward flow being the source of energy and driving the major magnetospheric convection pattern. The following phenomena are explained: (1) The tail plasma sheet is formed by the outward Hall drift of plasma from the storm-time radiation zone. (2) On a smaller scale, bubbles of plasma from the radiation zone are released into the tail, accounting for the observed islands of tail electrons, spikes of electrons seen just above the ionosphere, and energetic protons (≥300 keV) which have been seen in the tail. (3) The storm or bay ionospheric current system (DP1) develops from the quiet-time system (DP2) as a result of the magnetospheric space charge field and changed ionospheric conductivity caused by auroral precipitation. (4) Quiet auroral arcs and auroral substorms are due to electron precipitation from regions of low magnetic field strength, where the first invariant (of trapped particles) is lost. The intermittent ejection of plasma from the radiation belt suggests that the model be termed the burping radiation belt. (auth) (STAR)

36808 (N-68-17072) FIELD ALIGNED ELECTRON BURSTS AT HIGH LATITUDES OBSERVED BY OGO-4. Hoffman, R. A.; Evans, D. S. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1967. 43p. (NASA-TM-X-63093; X-611-67-592). CFSTI.

In a series of passes in the northern high latitude region, short bursts of radiation were observed in the energy range 0.7 to 24 keV by detectors aboard the polar orbiting satellite OGO-4. Among these bursts were a number in which the pitch-angle distributions at 2.3 keV displayed a maximum at small angles to the magnetic field lines. From the distributions and energy spectra it is argued that a possible source mechanism for these particles is electric fields parallel to the magnetic field lines at distances of several R_E. The source particles would then be the ambient thermal plasma, with two markedly different temperature components, one at a few eV, from which the field aligned radiation originates, the other greater than an order of magnitude hotter, which produces the isotropic portion of the pitch angle distribution. (auth) (STAR)

36809 (N-68-21904) PHASE AND GROUP REFRACTIVE INDICES FROM THE COLLISIONLESS MAGNETOIONIC THEORY. Colin, Lawrence; Chan, Kwok-Long; Lee, Jack G. K. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). Apr. 1968. 130p. (NASA-TM-X-1553). CFSTI.

Graphs of phase and group refractive indices computed from the collisionless magnetoionic theory are presented. The indices are computed for both the entire range of electron concentration and the intensity of the earth's magnetic field to be encountered by operational topside ionospheric sounders in the International Satellites for Ionospheric Studies (ISIS) series (Alouette I, Explorer XX, Alouette II, ISIS-A, and ISIS-B). (auth) (STAR)

36810 (N-68-22366) ON SOME QUESTION OF ELECTROMAGNETIC WAVES' DIFFRACTION ON PLASMA FORMATIONS. Gil'denburg, V. B.; Zhidko, Yu. M.; Kondrat'yev, I. G.; Miller, M. A. Translated for Volt Technical Corp., Washington, D. C., from Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 1358-75(1967). 21p. (NASA-CR-94361; ST-PP-EMWD-AI-10707). CFSTI.

This review paper is the consequence of plasma introduction as a medium with specific electromagnetic properties in the problems of diffraction. The diversified requirements for practical applications, for radiocommunication in the presence of ionization irregularities, and with regard to the ionosphere are contained in four major sections: (1) limiting cases of low and high plasma density — Born approximation, and dense plasma with sharp or weakly blurred boundaries; (2) numerical computations and shortwave approximation for a plasma of any density — reflection from a uniform nonabsorbing sphere, weak plasma boundary washing, and plasma with strongly washed boundary; (3) resonance scattering on small plasma objects — dipole resonance in cold plasma; and (4) diffraction on bodies placed in a nonuniform plasma. (auth) (STAR)

36811 SOME REGULARITIES IN THE PROBLEM OF SOLAR ACTIVITY AND THE EARTH'S ATMOSPHERE. Mustel, E. R. (Astronomical Council, Moscow. Hydrometeorological Center, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 932-41(May-June, 1968).

Translated from Astron. Zh., 44: 1162-75(Nov.-Dec., 1967).

A discussion is given of the reaction time of the lower layers of the Earth's atmosphere to the preparation of corpuscular fluxes into the magnetosphere. It is based on meteorological data covering most of the continental USSR and lists of times t_m representing the first days of geomagnetic disturbances. The disturbances selected are those occurring in the period 1890 to 1965 which were relatively free from overlap. The reaction time $t_M - t_m$ is shown for stations in the USSR. There is a pressure peak in the cold half of the year at which $t_M - t_m \simeq +2^d.5$. The reality of Sun–atmosphere relationships are confirmed. A discussion is given of the law of accentuation and seasonal fluctuations in Sun–atmosphere effects. The law of accentuation is confirmed and the need for studying Sun–atmosphere effects separately for each season of the year is shown. A discussion of the global distribution of Sun–atmosphere effects is presented. The curve of variation in atmospheric pressure at Canadian island stations in the north polar region is shown. The development of a geomagnetic disturbance here is accompanied by a drop in surface pressure and the decay of a geomagnetic disturbance by a pressure rise, but all of this occurs with a 24-h time lag. It is shown that corpuscular fluxes act on the Earth's atmosphere simultaneously in the northern and southern (coast of Antarctica) hemispheres. (auth)

36812 ALTITUDE VARIATIONS IN THE MAIN ISOBARIC SURFACES FOLLOWING SOLAR FLARES. Usmanov, R. F. (Hydrometeorological Center, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 942-4(May-June, 1968).

Translated from Astron. Zh., 44: 1176-9(Nov.-Dec., 1967).

Variations in the geopotential heights of the main isobaric surfaces in the northern hemisphere following solar flares observed in 1956–1961 are examined. The results confirm the previously observed reaction of the free atmosphere to variations in the intensity of solar corpuscular fluxes. (auth)

36813 DIRECT STUDIES OF THE DIURNAL CONCENTRATION PROFILE VARIATION OF CHARGED PARTICLES BELOW 90 KM Bragin, Yu. A. Kosm. Issled., 5: 951-2(Nov.-Dec. (1967). (In Russian).

New data on the concentration of charged particles from 10 rocket measurements are given for average USSR latitudes in June 1966. The concentration of charged particles is not the same by day and by night. The data pointed up the following diurnal changes which had not been previously detected. By day the lower limit of the stratospheric ion maximum is 5 to 10 km closer to the earth's surface than by night. A small local maximum of ion concentration is observed at night and in the morning in the region of the tropopause (7 to 13 km). A maximum charged particle concentration, which is smoothed out by a general increase of ions and electrons in the daytime, exists at a height of about 80 km with a low position of the sun. A local ion maximum is also noted in bright light at 40 to 50 km. A general ion increase is observed at night at this height. The data are presented graphically to give the ion concentration by day and by night at heights of 0 to 90 km. (TTT)

36814 EFFECT OF MAGNETIC STORMS ON DUCT FORMATION FOR WHISTLER PROPAGATION. Somayajulu, V. V.; Tantry, B. A. P. (Banaras Hindu Univ., India). J. Geomagnet. Geoelec., 20: 21-31(1968).

Sonagrams of a large number of whistlers recorded during the magnetic storm of January 13 to 15, 1967, are presented to illustrate the formation of ducts corresponding to path latitudes of 24, 27, and 31° and vlf duct formation during the main phase of the magnetic storm is attributed to the enhanced electron density produced in the F2-region heights and above up to ~R_E. A correlation between the K_p index and the whistler occurrence during the storm is drawn and the enhanced whistler activity is explained in terms of additional vlf ducts produced for whistler mode of propagation. From a large number of whistlers recorded during the storm, it is inferred, contrary to the idea of Smith, that though the formation of ducts can take place in much less than 30 minutes, once the duct has formed it can persist for at least 2 to 3 days. It is found that usually whistlers have pure gliding tones during quiet days while most of the whistlers recorded during the disturbed days show a large amount of diffuseness, which has been attributed to the propagation of vlf waves within a wide area of the duct. This is in contrast to the idea of Crouchley and Finn who show that diffuseness increases with dispersion. From the diffuseness of sonagrams of the whistlers, the effective width of the vlf ducts for waves of 5 kc were calculated and are found to vary from 15 to 25 km for normal whistlers and 40 to 180 km for those recorded during the magnetically disturbed days. (auth)

36815 ADMITTANCE OF AN INFINITE CYLINDRICAL ANTENNA IN A LOSSY, COMPRESSIBLE, ANISOTROPIC PLASMA. Miller, Edmund K. (Univ. of Michigan, Ann Arbor). Can. J. Phys., 46: 1109-18(May 1, 1968).

An analysis of the current on an infinite cylindrical dipole antenna which is excited across a circumferential gap of non-

zero thickness and immersed in a lossy, compressible magnetoplasma with its axis parallel to the static magnetic field is described. Some numerical results are presented for the antenna admittance for the sheathless case, where the uniform magnetoplasma is in contact with the antenna surface. The admittance values are obtained from a numerical integration of the Fourier integral for the antenna current, and are given for plasma parameter values typical of the E region of the ionosphere. The admittance values obtained exhibit a maximum slightly above the electron cyclotron frequency, and in this regard are similar to the admittance when the magnetoplasma is incompressible but separated from the antenna by a free-space layer (the vacuum sheath). In addition, the admittance is found to have a slight minimum at the plasma frequency and to have a more pronounced minimum at the upper hybrid frequency where also the susceptance changes sign, these minima not being significantly affected by the plasma compressibility or vacuum sheath. These features of the calculated admittances are found to have a qualitative resemblance to experimental results obtained from antenna measurements in the ionosphere. (auth) (Canada)

36816 DETERMINATION OF THE LOCAL ELECTRON CONCENTRATION IN THE OUTER RANGES OF THE IONOSPHERE BY MEANS OF THE COHERENT FREQUENCY METHOD, USING SATELLITES. Sinel'nikov, V. M. Kosm. Issled., 6: 316-18 (Mar.-Apr. 1968). (In Russian).

The orbital geophysical observatory ORO-A was used to determine the electron concentration by means of the Kosmos and Elektron series of satellites in the outer ionosphere. The measurements were carried out at a distance of several Earth radii by determining the Doppler shift of coherent radiowaves emitted by the satellite. It was found that the method proposed by Ya. A. Al'pert in 1958, and subsequent treatment of the data at coherent frequencies, allows information to be obtained about the electron concentration along the orbit of the satellite. Discrepancies observed in comparison with earlier calculations are attributed to inaccuracies in the original orbital data. (TTT)

36817 SIMPLE MODEL OF THE EQUATORIAL ELECTROJET. Suzuki, A.; Maeda, H. (Kyoto Univ.). J. Geomagnet. Geoelec., 20: 51-3(1968).

Several models have been presented for the structure of the equatorial jet current. A linear current or a band current of uniform intensity has often been supposed for discussing the associated magnetic effects. More detailed and complicated models have been proposed on the basis of theoretical considerations and compared with ground and/or rocket observations. The purpose of this communication is to propose a new simple model of the height-integrated jet current as deduced from ground observations, and to discuss its reliability in comparison with theory and rocket observation. (W.D.M.)

36818 SIMILARITIES IN THE ANNUAL BEHAVIOR OF THE STRATOSPHERE AND THE D AND E LAYERS OF THE IONOSPHERE. Schwentek, H. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Z. Geophys., 34: 123-46(May 1968). (In German).

The main purpose of this paper is to show that at temperate latitudes there is a remarkable difference in the behavior of several atmospheric parameters in summer and winter, respectively. The results suggest that the atmosphere from the ground up to the E layer of the ionosphere should be considered as a whole, and that the behavior of single parameters such as temperature, ionospheric absorption, electron density, etc., should be considered only as separate indications of a complicated overall change from summer to winter. It is pointed out that a complete system of parameters should finally be determined including the essential parameters of the Sun's radiation. Since the mean sunspot number R correlates rather well with the solar radio flux at 2800 MHz, R still can be used as a long-time parameter of the Sun's activity until detailed (daily) and precise measurements of the solar radiation at 1216 Å and in the x-ray band (0.1 to 100 Å) are available. (auth)

36819 OBSERVATION OF THE DIURNAL INTENSITY VARIATIONS OF CAPTURED ELECTRONS. Vaisberg, O. L. Kosm. Issled., 6: 311-13(Mar.-Apr. 1968). (In Russian).

An electric field along the direction of the drift of charged particles in an inhomogeneous magnetic field changes the energy of the particles in function of the potential distribution along the drift trajectory; in the geomagnetic field, this results in a change of the pitch angles. Following up electron intensity measurements in the >40 keV range using the instruments aboard the Kosmos-5 satellite, the intensity diagram of these electrons intensities was plotted in B, L coordinates, calculating for each individual measurement the deviations ΔB along the lines of force at L = const. of the observed intensity. Steps were taken to reduce the influence of the longitudinal effect. Analysis of the diurnal and semidiurnal harmonics confirmed the statistical reliability of the data obtained by means of Chapman's method. The electric field tension, determined in a perpendicular direction with respect to the lines of force, amounted to about 2×10^{-5} v/cm. Evidence was also obtained that the electric fields induced by the diurnal variations affect the captured particles. (TTT)

36820 ESTIMATE OF PROTON TEMPERATURE OF THE INTERPLANETARY PLASMA FROM DATA OBTAINED ON THE SPACE SHIP VENUS-3. Breus, T. K.; Gringauz, K. I. Kosm. Issled., 5: 948-50(Nov.-Dec. 1967). (In Russian).

A charged-particle trap was used to obtain the parameters of the solar wind from 0 to 3600 eV in Nov. 1965 on board Venus-3. Analysis of these spectra which gave the number of charged particles N in cm^{-2} sec^{-1} as a function of the energy led to an estimate of the proton temperature in the solar wind. The spectra reflect the velocity distribution of the solar wind particles. The threshold sensitivity of the particle trap was limited to $\sim 10^7$ cm^{-2} sec^{-1}. The z axis was chosen to coincide with the direction of the incident ion flux. The particle distribution in a solar wind having a velocity v_0 is assumed to be Maxwellian. This distribution is derived experimentally for average energies over small energy intervals, and the proton temperature T was estimated to be 1 to 5×10^5 °K at distances of 10 million kilometers from the earth. The maximum error was 15 to 20%. This temperature determined from the velocity dispersion may not be a measure of the true, chaotic thermal motion in the plasma. (TTT)

36821 DETERMINATION OF THE MAGNETOSPHERIC PLASMA DENSITY BY THE USE OF LONG-PERIOD GEOMAGNETIC MICROPULSATIONS. Kitamura, T.; Jacobs, J. A. (Univ. of British Columbia, Vancouver). J. Geomagnet. Geoelec., 20: 33-44(1968).

A new method of determining the magnetospheric plasma density distribution is presented, using long period geomagnetic micropulsations (period 45 to 600 sec.). Long period micropulsations are assumed to be caused by resonant oscillations of geomagnetic lines of force in the magnetosphere. Eliminating the time-dependent factor from the wave equations leads to an ordinary differential equation that depends on a spatial parameter only. With certain boundary conditions assigned beforehand (which may be determined by observation), the differential equation uniquely determines the "spatial form" of the oscillation if the plasma density distribution is known. A distribution is determined so that the spatial form is that of the fundamental and of the second harmonic, since these modes are the most likely to be excited. Results are compared with other investigations and good agreement is obtained with those from the IMP-II satellite. (auth)

36822 MEASURFMENT OF ELECTRON DENSITY PROFILES IN THE LOWER MAGNETOSPHERE WITH A SOUNDING ROCKET. Melzner, F.; Rabben, H. H.; Rothermel, H. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Z. Geophys., 34: 105-21(May 1968). (In German).

On April 22, 1966, above the Sahara, the electron density was measured up to 2000 km with a sounding rocket of the type RUBIS. After burnout of the rocket a transmitter was ejected, which then accompanied the rocket with an increasing distance. The frequency of the waves emitted by the transmitter was continuously and periodically swept between 0.3 and 3 MHz. The waves were recorded by two receivers on board the rocket. From the behavior of the waves between the transmitter and the rocket the electron density should be calculated according to Appleton's dispersion equation $n = n(\vartheta)$. The density should be determined especially from the frequency limit up to which energy can be transmitted by electromagnetic waves. Due to a defect in the transmitting antenna (which was 160 m in length) this frequency limit could not be detected. Instead the frequency of the poles of the dispersion equation could be measured at several points of the trajectory. From this the electron density and the angle between the direction of the magnetic field and the propagation direction could be calculated. During the descent of the rocket, plasma oscillations were recorded, which apparently arose by the supersonic speed of the rocket. The upper limit of the observed frequency band was supposed to correspond with the hybrid frequency. The electron density evaluated from this agreed with that evaluated from the pole frequencies. The physical fundamentals for electron density measurements are represented, the developed measuring equipment is described, and the results are reported on. (auth)

36823 INFLUENCE OF A RADIAL MAGNETIC FIELD ON THE RESONANCES OF A SPHERICAL PLASMA CAVITY. Large, David B.; Wait, James R. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 3: 633-7(June 1968).

A method is described for calculating the resonance charac-

teristics of the earth–ionosphere cavity. Particular attention is paid to the influence of the geomagnetic field which, for purposes of the analysis, is assumed to be purely radial. In the model used, the ionosphere is represented as a homogeneous concentric shell, which is regarded as a cold electron plasma with collisions. It is found that the geomagnetic field lowers the real resonance frequencies from those for the corresponding isotropic model. (auth)

36824 FULLY DEVELOPED TURBULENT IRREGULARITIES IN THE IONOSPHERE DUE TO CROSS-FIELD PLASMA INSTABILITY. Sato, Tetsuya; Tsuda, Takao; Maeda, Ken-ichi (Kyoto Univ.). Radio Sci., 3: 529-34(June 1968).

Diffuse nonblanketing type sporadic E layers of midlatitudes are considered in the light of recent plasma instability theory. Some irregularities observed in the E region do not seem to be associated with the wind-shear mechanism. Computer study of nonlinear cross-field instability strongly suggests that this instability is responsible for irregularity formation in the E region of midlatitudes. (auth)

36825 PI EVENTS WITH PARTICULAR REFERENCE TO CONJUGATE POINT PHENOMENA. Jacobs, J. A. (Univ. of Alberta, Edmonton). Radio Sci., 3: 539-44(June 1968).

The morphology of irregular micropulsations Pi2 is discussed with particular reference to their polarization, frequency spectrum, and relation with the Kp index of magnetic activity. Pi activity at the near conjugate auroral zone stations of Great Whale River and Byrd is examined in some detail. Other types of Pi activity (SIP's and IPDP's) are discussed and theories of Pi's and possible source mechanisms for Pi2's are reviewed. (auth)

36826 THE DOUBLE-PEAK DISTRIBUTION OF THE AMPLITUDE OF THE RADIO WAVE RETURNED FROM THE SPORADIC E LAYER. Khastgir, S. R.; Ganguly, S.; Samanta, S. (Bose Inst., Calcutta). Radio Sci., 3: 535-7(June 1968).

An attempt was made to account for the observed double-peak amplitude distribution for the vertically directed radio pulses returned from the sporadic E region in terms of the double layer that is occasionally formed in that region. (auth)

36827 CHARACTERIZATION OF THE PULSATION ACTIVITY OF THE GEOMAGNETIC FIELD FOR INDIVIDUAL DAYS AND ITS APPLICATION. Hollo, L.; Veroe, J. (Geophysical Lab., Sopron, Hungary). Acta Geodaet., Geophys. Montanistica, 2: 335-49(1967). (In German).

A correlation of pulsation activity was found with the h'F parameter of the ionosphere. The frequency of individual pulsation types was treated by telluric quick registrations at the observatory at Nagycenk between 1957 and 1965. The range between 1 and 600 sec was divided into 12 bands of periods, and each of these characterized by a character figure according to frequency. The relation of individual bands to each other and to magnetic activity during sunspot maxima and minima was determined by correlation studies. Further study was made of the behavior of pulsations with periods between 15 sec and 40 sec. Curves of certain groups deviate from others when a maximum of h'F between 30 to 80 km is reached in a given night; during the day they are all the same. The correlation was found to be more pronounced when days on which $\Sigma T > 30$ were selected for special comparison. (BBB)

36828 EFFECT OF COSMIC RAY UPON THE LOWEST LAYERS OF EARTH'S ATMOSPHERE. Mustel, E. R.; Bonelis, I. V.; Kubyshkin, V. V. (Inst. of Theoretical Astronomy, Leningrad). Astron. Tsirk., No. 333, 1-8(1965). (In Russian).

Quasi-stationary corpuscular fluxes from active regions of the sun and from chromospheric solar eruptions cause atmospheric changes which are practically synchronous with corresponding geomagnetic perturbations. Data from 34 stations on 41 chromospheric eruptions in Europe and USSR over the period from 1907 to 1960 were analyzed. It is shown that the chromospheric solar eruption is accompanied by adsorption of radiowaves in the polar region of the earth with a decrease in atmospheric pressure. These effects were caused by subrelativistic protons emitted from the chromospheric eruption. The effect of a corpuscular flux on the troposphere leads to an increase in atmospheric pressure which is synchronized with oscillations in the earth's magnetic field. This effect masks the proton phenomenon taking place at the polar cap. (TTT)

36829 EVALUATION OF MAGNETIC FLUCTUATIONS DETERMINED BY TURBULENCE IN THE LOWER IONOSPHERE. Lehmann, Hanns-Rainer (Geomagnetische Institut, Potsdam, Ger.). Beitr. Geophys., 77: 66-74(1968). (In German).

Turbulent conditions in the ionosphere are studied on the basis of an atmospheric model with homogeneous isotropic turbulence. The spectrum of inhomogeneities is determined through kinematic viscosity and the rate of dissipation of turbulent energy, these parameters being calculated from data from rocket experiments and others. Electromagnetic phenomena which may originate from lower ionospheric turbulence are discussed on the basis of these data. Electromagnetic variations of the pulsation type cannot be precisely defined through turbulence. Such variations demand a magnetic viscosity smaller than 10^8 cm^2/sec, which corresponds to a conductivity of 100 ohm^{-1}m^{-1}; under normal conditions the conductivity is 5 to 6 orders of magnitude smaller. In spite of great turbulence intensity in the E layer no magnetic fluctuations can be associated with it. (BBB)

36830 MEASURE OF ACTIVITY FOR FLUCTUATING LOCAL GRADIENTS OF THE GEOMAGNETIC FIELD. Schmidt, Herbert (Adolf-Schmidt-Observatorium fuer Erdmagnetismus, Niemegk, Ger.). Beitr. Geophys., 77: 50-6(1968). (In German).

An index g_z to characterize the activity of fluctuating local gradients of the Earth's magnetic field is proposed. Eleven classes of variations in local gradient are numbered from 0 through 9 to T on a quasi-logarithmic scale, and assignment to a class is based on maximum deflection of the local gradient recorder per time interval. The time intervals are generally less than one hour, data being lost in a 3-hr period. An example is given for September 1966, and daily summations and hourly summations per month are calculated. The latter are then plotted for a year of high solar activity (1959) and a year of low activity (1966). The g_z values are related to K, and the differences between them and their correlations are discussed. One distinction is that g_z is determined in a short time interval; on this basis the monthly three-hour summations of K for 1959 and 1966 are compared with the g_z data. (BBB)

36831 FIELD STRENGTH PREDICTIONS FOR BACKSCATTER IONOSPHERIC SOUNDING. Barclay, L. W. Marconi Rev., 31: 32-42(First Quarter 1968).

As an aid in the interpretation of the returns from backscatter ionospheric sounding transmissions, some predictions were prepared of the expected backscattered field strengths. Some parameters in the prediction process were not adequately known and, therefore, the computed field strengths could only indicate the possible order of magnitude of the received signal. Predictions were prepared for six specific times on a particular path across Europe. Three particular hours in the two solstice months at sunspot minimum were examined and the ionospheric propagation modes and losses for two frequencies predicted. Calculations were made for a path due east from Essex to a distance of 4000 km. The field strengths were predicted for 5 and 10 MHz at 08, 14, and 22 GMT. The first step in the procedure was to prepare field-strength predictions for the possible propagation modes assuming a lossless scatter return and 3-MW equivalent isotropically radiated power at all elevation angles. An example of this step, for 0800 GMT in June, is shown. These curves were then modified to include both the vertical radiation pattern of the aerial and the backscatter coefficient which was obtained. The 6 sets of curves, one for each time at which predictions were made, are illustrated. The results showed that the returns, particularly in daytime, are restricted to relatively narrow range bands. (BBB)

36832 ON PROGNOSIS OF DIURNAL VARIATION OF THE CRITICAL FREQUENCY OF THE IONOSPHERIC F2 LAYER. Singler, A. Arch. Meteorol. Geophys. Bioklimatol., Ser. A, 16: 371-81(1967). (In German).

An interpolation formula empirically derived from ionospheric data of a station for diurnal variation of the critical frequency of the F2 layer was tested with reference to measured relative numbers of sunspots. In many control examples, calculated and observed values agree well; this is particularly true for the phase position of the extremes of the diurnal variation. Differences between measured and calculated values can be partially ascribed to the structure of the empirical formula and partially ascribed to erroneous prediction (monthly mean) of the relative numbers due to their frequently observed strong short-term fluctuations. The form of the approximation is a finite Fourier series with another term comprising the mean daily value of f_0F_2. (BBB)

36833 MAGNETIC ENERGY DENSITY OF VARIATIONS OF LONG PERIOD DURING GEOMAGNETIC STORMS. Best, Adolf (Geomagnetisches Institut, Potsdam, Ger.). Beitr. Geophys., 77: 87-91(1968). (In German).

The magnetic energy density of fluctuations of long period (20 to 120 min), computed from power spectra of geomagnetic storms of moderate intensity, is shown to depend on the frequency of the fluctuations as well as the geomagnetic latitude. The spectral density increases from low to high latitudes. Power spectra are also computed for magnetically quiet periods for comparison. Digitally calculated filtered power spectra are illustrated and compared the X component (Dombas) and the H component (Niemegk). A separation of the periodic and non-

periodic portions is possible. The effect of the plasma stream is noted in the course of the power spectra for quiet and disturbed periods, and is expressed in the level of the magnetic energy density. Quadratic spectra can thus be used as measures of geomagnetic activity. (BBB)

36834 THE IONIZED CONSTITUENTS IN THE 100 TO 300 KILOMETER REGION OF THE EARTH'S UPPER ATMOSPHERE. Norton, Richard Bryce. Boulder, Colo., Univ. of Colorado, 1967. 181p.

Thesis.

A model of the upper atmosphere ion composition is constructed by combining the best available data for neutral composition, solar uv and x-ray flux, ionization cross sections and efficiencies, and molecular reaction rates. This model is compared with the ion and electron density profiles that have been obtained by a variety of means, including rocket and satellite experiments as well as ground based radar experiments. Because of their large coefficients in reactions with the ions, the atomic nitrogen (N) and nitric oxide (NO) concentrations are estimated. The calculated NO concentrations agree reasonably well with observations above 125 km but depart drastically at lower altitudes. Allowing for reactants that are nonthermal or in excited states (e.g., $N(^2D) + O_2$) may resolve this discrepancy. Atomic nitrogen concentrations of the order of 10^7 cm^{-3} or greater are estimated for the E and F1 region. The model is found to agree quite well with the observed height profiles of ion composition and is used to compute the ion concentration at various heights as a function of time (diurnal, seasonal and solar cycle) and compared with observation. However, in order to use the laboratory coefficient for the O^+ reaction, atomic oxygen concentrations must be used that are larger than the rocket-borne mass spectrometer observations but that are consistent with the ultraviolet absorption measurements. Good agreement is obtained with daytime electron density variations although diurnal variations in neutral composition are important in explaining the upper F region. The nighttime E region requires a source which is postulated to be scattered by Ly β. The nighttime F1 region appears to decay to quite low densities, of the order of 10^2 cm^{-3} except during magnetically disturbed periods when a layer is formed. It is argued that this layer is not likely to be due to transport alone. A small flux of energetic electrons is suggested as the ionizing source. Seasonal variations in F region electron densities are interpreted in terms of neutral composition changes. It is hypothesized that a seasonal change in the height of turbopause, which mainly alters the atomic oxygen concentration, is responsible for these changes. Solar cycle changes in the maximum density of the various ionospheric layers are related to changes in the solar ionizing flux. However, temperature induced changes in the neutral atmosphere are also important at fixed heights in the F region. The model is also used to calculate ion compositon and interpret the electron density variations under several special circumstances: severe storms associated with magnetic activity, solar eclipses, and F-region sunrise transitions in the equatorial region. (TSS) (Disser. Abstr.)

36835 PROBLEMS OF ANALYSIS OF THE RING CURRENT FIELD IN CONNECTION WITH THE D_{st} VARIATIONS. Grafe, Armin (Geomagnetisches Institut, Potsdam, Ger.). Beitr. Geophys., 77: 92–101(1968). (In German).

Ring-current disturbances are discussed in connection with variations of D_{st}. The ring current field is shown to be asymmetric. The asymmetry cannot be explained by a separation of the DR field into parts labeled DR 1 and DR 2. Differences in the D_{st} values from the ring current values for February 1958 are important particularly for data from Sitka, Fredericksburg, Niemegk, and Yakutsk; from Fredericksburg, Moscow, and Yakutsk; but not from Honolulu and M'Bour. DS values for stations at different geomagnetic latitudes for mean geomagnetic longitude (Big Delta, Sitka, Fredericksburg, Honolulu, Fanning Island, Jarvis Island, Apia, Niemegk, Castellacio, M'Bour, Bangui, Hermanus, and Mawson) are compared for February 1958. Values of ξ for Bangui and Fanning Island, and their difference, are illustrated for the same period. Perhaps it is possible to evaluate the DP disturbances in the equatorial regions from the disturbances in the polar regions. (BBB)

36836 TEMPORAL VARIATIONS IN GEOCORONAL BALMER ALPHA. Tinsley, Brian A. (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 73: 4139-49(July 1, 1968).

Measurements made between May 1965 and November 1967 of the Balmer-α emission arising from Lyman-α scattering in the geocorona were normalized to remove the effects of geometry of scattering. The remaining variations are interpreted in terms of variations in the column abundance and distribution of hydrogen in the geocorona, variations in the intensity of the line center of the solar Lyman-β flux, and possible variations in molecular oxygen distribution. Diurnal, annual, and solar cycle variations are found, together with probable fluctuations with periods of a few days. It is pointed out that there may be significant variations in hydrogen production rate that affect the column abundance. (auth)

36837 OBSERVATION OF FLOW OF LOW-ENERGY IONS AT SYNCHRONOUS ALTITUDE AND IMPLICATIONS FOR MAGNETOSPHERIC CONVECTION. Freeman, J. W. Jr. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 4151-8(July 1, 1968).

The Rice University suprathermal ion detector aboard the ATS 1 synchronous orbit satellite has established the existence of occasional bulk motion of the magnetospheric thermal ions. This conclusion is based on the observation of a highly directional flux of positive ions, moving with a flow velocity of approximately 30 km/sec with a thermal energy substantially less than the flow velocity energy. The flow direction and magnitude observed are generally consistent with present theories of magnetospheric convection. The electric field required to account for the observed flow velocity is 5 millivolts/meter, and the electric field direction is across the magnetosphere from the dawn to dusk side. A gross pattern of magnetospheric convection that is consistent with this, as well as previously reported ATS 1 data, is presented. Implications of the requisite electric field for the energetic trapped radiation in the outer portion of the outer zone of the Van Allen radiation belt are briefly discussed. (auth)

36838 ELECTRON PRECIPITATION IN THE RADIATION BELTS. Imhof, W. L. (Lockheed Missiles and Space Co., PPPAL Alto, Calif.). J. Geophys. Res., 73: 4167-84(July 1, 1968).

Fluxes and energy spectra are presented for electrons above an energy of ~0.4 MeV on a worldwide basis over the range of L values 1.6 to 7, as measured in the fall of 1963 on a low-altitude polar-orbiting satellite. The data were subjected to a systematic analysis in terms of the longitude variations in intensity and spectral shape. In contrast to the behavior at $L \lesssim 1.7$, significant fluxes of electrons are observed in the outer radiation belt at virtually all longitudes, and the energy spectra of the precipitating electrons are comparable to those of electrons trapped at minimum altitudes of 200 to 350 km. For the precipitating electrons, the data were analyzed in terms of the interval of longitude drift between the measurement location and the point where the B, L trace of the observation point was lost below 100 km in altitude. The rates of flux buildup with longitude drift are rather slow in the inner belt, whereas in the outer belt regions, the intensities rapidly build up to near equilibrium values. Comparisons were made of the rates of flux buildup with calculations of pitch-angle diffusion, using the Fokker–Planck formalism. Over a rather wide range of magnetic latitudes covering the outer radiation belt and slot regions, where the low-altitude precipitations vary enormously in magnitude, the diffusion coefficient varies by only a factor of 4 and is consistent with the dominant loss mechanism for trapped electrons being pitch-angle diffusion. (auth)

36839 DETECTION OF ALPHA PARTICLES IN AURORAL PHENOMENA. Reasoner, D. L.; Eather, R. H.; O'Brien, B. J. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 4185-98 (July 1, 1968).

A coordinated experiment with rocket-borne particle detectors and ground-based photometers has shown that the ratio of the differential flux of alpha particles with $E_\alpha \sim 200$ keV to protons with $E_p \sim 100$ keV was approximately 1.6% in an aurora on February 9, 1967. This value is consistent with ratios observed at that time by spacecraft in the solar wind but is not consistent with the ratio He^{2+}/H^+ of thermal ion densities measured between the ionosphere and an altitude of 20,000 km. These data argue that the energetic auroral ions were originally constituents of the solar wind and were accelerated at altitudes above 20,000 km by a mechanism that gives an energization proportional to the charge of the ion. The measured proton energy spectrum between a few hundred eV and 650 keV was used to predict the Hβ optical intensity; calculated limits of 35 to 105 Rayleighs were in good agreement with the measured value of 46 R. An experimental upper limit of 1R for the λ5876 He(I) intensity is not inconsistent with the alpha-particle flux. Theoretical implications of these several results are discussed. (auth)

36840 MEASUREMENTS AND INTERPRETATION OF LOW-ENERGY PHOTOELECTRONS. Shea, M. F. (Lockheed Missiles and Space Co., Palo Alto, Calif.); Sharp, R. D.; McElroy, M. B. J. Geophys. Res., 73: 4199-4212(July 1, 1968).

Measurements of the photoelectron spectrum at White Sands Missile Range in June 1965 are reported and compared with theory. The agreement is satisfactory and shows that a realistic treatment of photoelectrons, at least at low altitudes, is feasible with current information on atmospheric structure, solar fluxes, and cross sections. The theoretical model is also compared with

measurements by Hinteregger in August 1959. Theory and experiment agree satisfactorily in this case also if one assumes a solar-cycle variation of extreme ultraviolet solar radiation comparable with that observed for the 10-cm radio flux. (auth)

36841 REAPPEARANCE OF A STABLE AURORAL RED ARC AT MIDLATITUDES. Hoch, R. J. (Battelle-Northwest, Richland, Wash.); Marovich, E.; Clark, K. C. J. Geophys. Res., 73: 4213-16(July 1, 1968).

A stable auroral red (SAR) arc was recorded the night of September 28/29 from stations at Fritz Peak, Colorado, and Richland, Washington. The first direct determination of position and altitude of an SAR arc was accomplished by triangulation from these two stations. The appearance of this arc marks the definite recurrence of this phenomenon after an apparent absence of four years. The arc occurred southward of an intense auroral display, and it was aligned parallel to lines of constant L. Average intensity of [O I] 6300 A emission in the brightest part of the arc was approximately 150 R. Altitude of the brightest region was determined from angular coordinates at the two stations to be 400 km at 0745 UT. A typical width across the narrow dimension of the arc was 160 km between half-maximum intensity values. A sector of the arc almost 4200 km long was simultaneously within the combined range of the two stations. The arc occurred during a period of high magnetic activity, and though a comparably intense aurora borealis occurred the night before (September 27/28), no SAR arc was observed from either station. (auth)

36842 MACROSTRUCTURE OF GEOMAGNETIC BAYS. Rostoker, Gordon (Royal Inst. of Tech., Stockholm). J. Geophys. Res., 73: 4217-29(July 1, 1968).

Evidence is presented that suggests that geomagnetic bay disturbances occur in two stages. The onset of each stage is accompanied by a Pi 2 micropulsation; the fact that a Pi 2 occurs almost synchronously over the Earth's surface allows the onset of this micropulsation to be used to define the onset of each stage of a bay. The time lag between the onsets of the two stages ranges from about 10 to 30 minutes. The delay between the two stages is suggested to be the time required for the transfer of information from the front of the magnetosphere to the region of reconnection in the magnetotail. The recognition of the first stage of a bay as a precursor can facilitate high-resolution studies of auroral phenomena. (auth)

36843 ANALYSIS OF ORDINARY MODE STANDING WAVES OBSERVED BY ROCKETS IN THE E REGION. Monro, P. E.; Mechtly, E. A.; Sastry, R. S. (Univ. of Illinois, Urbana). J. Geophys. Res., 73: 4291-7(July 1, 1968).

A method of analysis of data telemetered from Nike–Apache rockets traveling in the region between the x ray and o ray reflection levels is described. The data give information about the standing-wave pattern resulting from interference between the radiation propagating directly from a ground-based transmitter and that propagating downward after an ionospheric reflection. Electron concentrations are obtained from the analysis. Results of a typical flight are shown in which electron concentrations are determined in the altitude range 105 to 150 km, and the accuracy of the results is discussed. (auth)

36844 DYNAMICS OF THE NEUTRAL GAS IN THE THERMOSPHERE FOR SMALL ROSSBY NUMBER MOTIONS. Dickinson, Robert E.; Lagos, C. Pablo; Newell, Reginald E. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 73: 4299-4313(July 1, 1968).

Equations describing the motions of the neutral gas in the thermosphere are formulated, nondimensionalized, and expanded in Rossby number. Adiabatic warming and cooling by vertical motions is comparable to the variable component of diabatic heating and can account for the large departures of observed diurnal and meridional temperature variations from the values predicted by one-dimensional diabatic models. To illustrate the application of the theory to the dynamics of the thermospheric diurnal oscillation, a series of numerical experiments, assuming a two-dimensional zonal strip, was carried out. Ion drag was neglected, and consequently the horizontal motion amplitudes (~700 m/sec) were unrealistically large. A steady diurnal oscillation in agreement with the observed diurnal bulge was obtained after an ad hoc reduction of the adiabatic heating by a factor of 4. Vertical motions shifted the phase of maximum temperature to a time three hours earlier than that obtained in the absence of motions. (auth)

36845 MINIMUM VARIANCE TECHNIQUE FOR THE ANALYSIS OF IONOSPHERIC DATA ACQUIRED IN SATELLITE RETARDING POTENTIAL ANALYZER EXPERIMENTS. Moss, S. J.; Hyman, Ellis (Wolf Research and Development Corp., College Park, Md.). J. Geophys. Res., 73: 4315-23(July 1, 1968).

A minimum variance iterative technique for the determination of ionospheric parameters, including electron and ion temperatures and densities, is presented. The method formally incorporates a priori information regarding the values of these parameters and, in particular, whatever information the experimenter has concerning the uncertainty associated with these values. With proper use of this additional information, convergence will be more rapid and more likely than would be the case were a priori information not employed. With certain mathematical models, singularities that occur in other techniques are avoided. In addition, procedures for generating nominal parameter estimates from the data have been devised. These techniques have been developed for, and lend themselves to, the automatic processing of large quantities of data. An example of the analysis of both ion and electron data is included for illustrative purposes. (auth)

36846 ANALYSIS OF IONOSPHERIC CONTRIBUTIONS TO THE DOPPLER SHIFTS OF CW SIGNALS FROM ARTIFICIAL EARTH SATELLITES. Tucker, A. J.; Fannin, B. M. (Univ. of Texas, Austin). J. Geophys. Res., 73: 4325-34(July 1, 1968).

Radio signals from artificial earth satellites propagated through the Earth's ionosphere are subjected to phase delay, refraction, and attenuation. These effects cause uncertainties in the determination of the vacuum Doppler shift of cw signals. To understand the nature of these ionospheric contributions to the Doppler shift, a theoretical expression for the refracted Doppler shift that is an inverse power series in terms of the frequency of the signal has been derived. A computer program has been written that uses ray theory in conjunction with a model ionosphere to evaluate each term of this expression. The nature of each term is discussed, and its relative importance is shown. The ionospheric contributions that are proportional to $(1/f)$ and $(1/f^2)$, which result from phase delay and refraction, respectively, are the predominate terms; therefore the effects of refraction on a radio signal can be connected by using three-frequency Doppler data. The ionospheric contribution that is proportional to $(1/f^3)$ is insignificant. Three-frequency Doppler data were recorded to evaluate the refraction effects in the refracted Doppler data. Two sets of experimental data are included that show the refraction effects. (auth)

36847 THEORY OF ELECTROMAGNETIC COUPLING PHENOMENA IN THE EARTH–IONOSPHERE CAVITY. Large, David B.; Wait, James R. (Inst. for Earth Sciences, Boulder, Colo.). J. Geophys. Res., 73: 4335-62(July 1, 1968).

The surface impedance matrix is calculated for a realistic model of the lower ionosphere under both daytime and nighttime conditions. For elf, this impedance is almost independent of angle of incidence and therefore may be used to characterize the outer surface of the hypothetical earth–ionosphere cavity. A solution is carried through for a ring magnetic source which includes, as a special case, excitation by a vertical electric dipole at the Earth's surface. Extensive numerical results are given first for a constant surface impedance. They illustrate many important features such as the dependence of the apparent resonant frequencies on the relative location of source and observer. The calculations are then extended to include an idealized day/night hemispheric model that demonstrates significant coupling between cavity modes with a resultant lowering of cavity Q's. The calculated results are discussed in relation to experimental data observed by other workers. (auth)

36848 EULER POTENTIALS AND GEOMAGNETIC DRIFT SHELLS. Stern, David (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 4373-8(July 1, 1968).

The equation of drift surfaces, traced by the guiding center motion of charged particles moving in a magnetic field, is discussed in terms of Euler potentials α and β. Particular attention is given to fields deviating to a limited extent from a dipole configuration, for which it is shown that the result is related to the drift-shell parameter L, with an added "shell-splitting function" G_1, which can be approximately derived. Such an approximation is used to derive shell splitting in a model of the magnetosphere, and the results are compared to exact ones obtained numerically. An improved drift shell parameter L', replacing McIlwain's L in this case, is also discussed. (auth)

36849 SOME PROPERTIES OF MAGNETOSPHERIC NEUTRAL SURFACES. Alfven, H. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 4379-81(July 1, 1968).

At the interface between two regions of plasma with opposite magnetization there may be flows of plasma toward the sheet from both sides. The particles brought to the interface form the sheet current necessary to produce the difference in magnetization. This model is applied to both the magnetopause and the neutral sheet in the tail. (W.D.M.)

36850 RELATIONSHIP BETWEEN THE ONSET OF A GEOMAGNETIC BAY AND THE CONFIGURATION OF THE INTER-

PLANETARY MAGNETIC FIELD. Rostoker, Gordon (Royal Inst. of Tech., Stockholm). J. Geophys. Res., 73: 4382-7(July 1, 1968).

A total of 35 well-defined bays occurred during the period between Dec. 1 and 14 when IMP 1 data were available, and a detailed study of the structure of the interplanetary field during each bay event revealed certain trends. These trends are discussed. (W.D.M.)

36851 OUTER-ZONE ELECTRONS AND THE INTERPLANETARY MAGNETIC FIELDS DURING TWO GEOMAGNETIC STORMS. Lanzerotti, L. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Geophys. Res., 73: 4388-92(July 1, 1968).

The connection between the interplanetary field data of Ballif et al. (1967) and the outer-zone electron flux changes during the Jan. 20 and Feb. 6 sudden commencement storms is discussed. A correlation between the magnitude of the southward interplanetary field component and the observed time of the nonadiabatic electron increases after the sc is discussed. Also evidenced is an apparent correlation between the persistence of the large southward component after the electron increases and the strength of the geomagnetic storm. No consistent correlation was found between the outer-zone electron increases during the two storms and the position of the Earth in the solar stream model constructed by Ballif and Jones. (W.D.M.)

36852 ARTIFICIAL PRODUCTION OF VLF HISS. Bell, T. F. (Stanford Univ., Calif.). J. Geophys. Res., 73: 4409-15(July 1, 1968).

In the summer of 1968 an experiment is planned by the Goddard Center in which an electron accelerator will be flown aboard an Aerobee 350 rocket from Wallops Island. The general purpose of the experiment is to generate an aurora by injecting an intense stream of electrons into the geomagnetic field parallel to a field line in such a way that the electrons will enter the atmosphere, deposit their energy, and produce an auroral spot. A discussion is given of what may be an observable side effect of the experiment, namely the production of broadband vlf hiss by means of the Cherenkov radiation process. (W.D.M.)

36853 METHOD OF MEASURING ELECTRON AND ION DENSITIES IN THE REGION OF 40 TO 80 KILOMETERS. Oster, A. L.; Coroniti, S. C. (Avco Corp., Lowell, Mass.). J. Geophys. Res., 73: 4421-4(July 1, 1968).

For the measurement of the mobility spectrum of small atmospheric ions in the altitude range between 30 and 80 km, a new type of ion mobility spectrometer has been developed. A brief description of the operating principle of this instrument, of the experimental setup, and the interpretation of the data is presented. (W.D.M.)

36854 ATOMIC NITROGEN IN THE UPPER ATMOSPHERE MEASURED BY MASS SPECTROMETERS. Ghosh, S. N.; Hinton, B. B.; Jones, L. M.; Leite, R. J.; Mason, C. J.; Schaefer, E. J.; Walters, M. (Univ. of Michigan, Ann Arbor). J. Geophys. Res., 73: 4425-6(July 1, 1968).

Two quadrupole mass spectrometers were flown on Aerobee NASA 4.027 UA, launched at 0657 MDT, August 8, 1967, at the White Sands Missile Range, New Mexico (32°23′N lat., 106°29′W long.). One spectrometer was ejected from within a vacuum at 101 km; the other remained with the rocket. Both instruments confirmed the existence of atomic nitrogen in the altitude range 120 to 280 km in agreement with results calculated by Ghosh (1968). (W.D.M.)

36855 ANOMALOUS D-REGION PARTIAL REFLECTIONS AFTER HIGH-YIELD NUCLEAR DETONATIONS. Stanley, Glenn (Univ. of Alaska, College). J. Geophys. Res., 73: 4430-3(July 1, 1968).

Examination of ionograms taken at College, Alaska, during October and November 1961 discloses the presence of anomalous reflections at very low virtual heights. The times of occurrence of these echoes suggest that they were a consequence of radioactive debris from large nuclear detonations at Novaya Zemlya. (W.D.M.)

36856 IONOSPHERIC PHASE FLUCTUATIONS OF SATELLITE TRANSMISSIONS. Millman, George H. (General Electric Co., Syracuse, N. Y.); Anderson, Roy E. J. Geophys. Res., 73: 4434-8(July 1, 1968).

The preliminary analysis of the differential phase measurements of the coherent frequencies, 162 and 324 MHz, emitted from the GEOS-1 satellite, Explorer 29, is presented. The observations were conducted at the General Electric Radio–Optical Observatory, located near Schenectady, New York, in May and June 1966. (W.D.M.)

36857 PROPAGATION OF ELF AND VLF WAVES BELOW MODELS OF NATURALLY PERTURBED IONOSPHERES. Galejs, Janis; Mentzoni, Michael (Sylvania Electronic Systems, Waltham, Mass.). J. Geophys. Res., 73: 4439-43(July 1, 1968).

Ionospheric density profiles are used in conjunction with available collision frequency data for computing phase velocities and attenuation rates of elf and vlf fields in the air space below the ionosphere. The effects of ions are not considered. (W.D.M.)

36858 IONOSPHERIC G FACTOR. Mentzoni, Michael (Sylvania Electronic Systems, Waltham, Mass.). J. Geophys. Res., 73: 4444-5(July 1, 1968).

An evaluation of G(air) is given, based on the following room temperature values: $G(N_2) = 2.2 \times 10^{-3}$ and $G(O_2) = 2.3 \times 10^{-2}$. It is assumed that complete mixing exists between nitrogen and oxygen and that the air consists of 78% N_2 and 21% O_2. It is concluded that the very large value of the G factor in oxygen found in the laboratory and supported by theory does not contradict findings based upon ionospheric cross-modulation measurements. (W.D.M.)

36859 DISCUSSION OF PAPER BY ANTONIO ALFONSO-FAUS, "SOLAR WIND AND PLANETARY ROTATION". Burns, J. A. (Goddard Space Flight Center, Greenbelt, Md.); Alfonso-Faus, A. J. Geophys. Res., 73: 4449-51(July 1, 1968).

Alfonso-Faus (1967) has presented a calculation showing that the solar wind striking a planet (or striking the particles that make up the protoplanet) might account for the present planetary rotations. It is shown that his form for the planet's rotational angular velocity is changed because of a correction in the length to be used for the radius of the protoplanet; this change amounts to an increase of about a factor of 5 for most of the planets. It is further shown that there is a decrease of about an order of magnitude in the coefficient for the couple acting on the planet and that the length of time over which the mechanism is effective should be shortened. These last two changes make it less probable that the solar wind is responsible for planetary rotation; this note does, however, indicate the requirements that must be satisfied for this mechanism to be effective. (W.D.M.)

36860 DISCUSSION OF ABSTRACT BY R. D. ALBERT, "DETECTION OF THE PRESENCE OF ALPHA PARTICLES IN AURORAL FLUXES". Wax, R. L.; Bernstein, W. (TRW Systems, Redondo Beach, Calif.). J. Geophys. Res., 73: 4452-4(July 1, 1968).

In a recently published abstract, Albert (1967) states that he has observed an alpha-particle flux in the aurora that is 7% of the proton flux and that has an e-folding energy of 5 keV. At altitudes less than 250 km, the atmosphere is at least three charge-exchange–stripping equilibrium thicknesses. The authors point out an inconsistency in Albert's work. A replay by Albert is included. (W.D.M.)

36861 DISCUSSION OF PAPER BY Y. KONDO AND J. E. KUPPERIAN, JR., "INTERACTION OF THE NEUTRAL HYDROGEN AND CHARGED PARTICLES IN THE RADIATION BELTS: THE CONSEQUENT LYMAN-ALPHA EMISSION". Donahue, T. M. (Univ. of Pittsburgh). J. Geophs. Res., 73: 4455-8(July 1, 1968).

Various reasons are given and discussed for concluding that excitation of terrestrial hydrogen by electronic collisions is neither necessary nor sufficient as a mechanism to account for an appreciable part of the nightglow Lyman-α radiation. A reply by Kondo and Kupperian is included. (W.D.M.)

Low-Temperature Physics

Refer also to abstracts 36137, 36496, 36703, 36760, and 37237.

36862 (COO–1054–41) THE BEHAVIOR OF THE CRITICAL FIELD OF QUENCHED THIN Pb, Sn, AND In FILMS: ITS ANGULAR DEPENDENCE AND ITS RELATION TO CHANGES IN DEFECT CONCENTRATION, CRYSTALLIZATION, AND MEAN FREE PATH. Schiller, Charles K. (Wayne State Univ., Detroit, Mich.). 1968. Contract AT(11-1)-1054. 104p. Dep. CFSTI.

Thesis.

The critical field behavior of superconducting thin films of Pb, Sn, and In, quenched on substrates held at liquid He temperatures, was investigated. The experimentally determined angular dependence of the critical field, H_c, was compared with the prediction of the Tinkham theory, which also provided a means for estimating the electronic mean free path, l, from the measured critical field values. These l values are compared with the nominal crystallite sizes for similarly formed films as determined by electron-diffraction experiments performed by Bulow and Buckel. The films were formed by quenching the metal vapor on a perpendicular-cut quartz single-crystal substrate held at liquid He temperature. After the evaporation process, measurements were begun of the dependence of H_c on θ, where θ is the angle between the field and the plane of the film. The transition was measured resistively.

using currents of 0.80 mA, orthogonal to the field and normal to the film. The films were warmed up to successively higher temperatures up to room temperature. After each annealing stage measurements were made with the film recooled to liquid He temperature. The angular dependence measured was found to follow the theory for the Pb and Sn films for all annealing temperatures if H_c was defined as the field at which one-half of the normal residual resistivity was restored. For In the angular dependence follows the theory except for the 300°K anneal, for angles in the range from approximately 0° to 30°. For the metals investigated it was found that there is a relation between the electron-diffraction-determined nominal crystallite size (a) and the calculated mean free path values (l) where $a = c \times l$, for the temperature range of 6 to 300°K. The value of c is dependent on the film under consideration. (auth)

36863 GINZBURG–LANDAU THEORY OF SURFACE SUPERCONDUCTIVITY AND MAGNETIC HYSTERESIS. Christiansen, P. Voetmann; Smith, Henrik (Univ. Fysiske Lab., Copenhagen). Phys. Rev., 171: 445-58(July 10, 1968).

The magnetization properties of a long superconducting cylinder with an ideal surface and a radius much larger than the low-field penetration depth are discussed on the basis of numerical solutions to the one-dimensional Ginzburg–Landau equations for a half-space. The current-carrying properties of the complete set of nodeless surface solutions and Meissner solutions are discussed in detail, and a separate numerical investigation of infinitesimal solutions is included. A stability criterion is derived, and infinitesimal solutions are shown to be unstable below H_{c3}. Finally these results are used for determining critical currents and magnetization curves. It is shown that there is a new kind of superheating and supercooling due to the shielding properties of the surface sheath. (auth)

36864 COMPLEX RADIO-FREQUENCY IMPEDANCE OF TYPE-II SUPERCONDUCTORS. Possin, George E.; Shepard, Kenneth W. (Stanford Univ., Calif.). Phys. Rev., 171: 458-60 (July 10, 1968).

The complex ac impedance of a type-II superconductor in the intermediate state has been measured between 3 and 40 MHz. The results are compared with a model of vortices acted on by a pinning force and the Lorentz force. Also, the inertial inductance of the superelectrons has been measured at 10 MHz and is shown to be sufficiently large, for thin films, to provide a convenient measure of the penetration depth. (auth)

36865 TEMPERATURE DEPENDENCE OF THE FLUX-FLOW RESISTANCE NEAR H_{c2} IN TYPE-II SUPERCONDUCTORS. Axt, Carl J.; Joiner, W. C. H. (Univ. of Cincinnati). Phys. Rev., 171: 461-5(July 10, 1968).

It was found that at nonzero temperatures the flux-flow resistivity in type-II superconducting foils is exponential in field near H_{c2}. The fraction of the normalized resistivity that can be represented by the exponential field dependence increases as the temperature approaches T_c. The quantity $\alpha = [(H/\rho_N) \times (d\rho_F/dH)]_{H=Hc2}$ increases monotonically with temperature, in qualitative agreement with the recent theory of Caroli and Maki, but quantitative comparison of the temperature dependence indicates substantial disagreement. The exponential dependence of the flux-flow resistivity on field suggests that overlap of fluxoids may be important in determining the resistivity at high fields. Alternatively, a recent theory of Clem's describes a thermal dissipation mechanism in addition to the electrical dissipation (Joule heat). Inclusion of this thermal dissipation yields results qualitatively suggestive of those presented here. (auth)

36866 TETRACYANOQUINODIMETHANE DERIVATIVES OF CYANINE DYES: A MODEL FOR ORGANIC SUPERCONDUCTORS. Lupinski, J. H.; Walter, K. R.; Vogt, L. H. Jr. (General Electric Research and Development Center, Schenectady, N. Y.). Mol. Cryst., 3: 241-50(Nov. 1967).

Recently it was suggested that certain organic materials could act as superconductors at temperatures much higher than the conventional inorganic superconductors. In view of the complicated nature of the proposed compounds this idea could presumably only be tested directly if a simpler system could be found. For that purpose a number of 7,7,8,8-tetracyanoquinodimethane (TCNQ) derivatives of cyanine dyes were prepared and their electric conductivities were measured in a simple way. Their conductivities (2.5×10^{-3} to 8×10^{-11} ohm^{-1} cm^{-1}) are comparable to those of other TCNQ derivatives. No indications of an enhanced conductivity due to the presence of the highly polarizable cyanine cations were noted. (BBB)

36867 EXPERIMENTAL OBSERVATION OF ELECTROMAGNETIC RADIATION FROM Sn/Pb, Pb/Pb, AND In/In SUPERCONDUCTING TUNNEL JUNCTIONS. Dmitrenko, I. M.; Yanson, I. K.; Yurchenko, I. I. (Inst. of Physics and Tech. Low Temperatures, Kharkov). Sov. Phys.-Solid State (Engl. Transl.), 9: 2889-90(June 1968).

Translated from Fiz. Tverd. Tela, 9: 3656-8(Dec. 1967).

The results of an experimental investigation of the features of the current–voltage characteristic connected with the generation of radiation from Pb–Pb superconducting tunnel junctions are reported. The current–voltage characteristic showed a stepped structure similar to that previously observed for Sn–Sn junctions, but having a significant spreading of the steps with high resonance numbers. Radiation from Sn–Pb and Pb–Pb junctions was recorded directly in the 3-cm wavelength band. The radiation frequency and the potential on the junction satisfied the Josephson frequency relationship within the limits of accuracy of the experiment. It is concluded that the Josephson electromagnetic radiation is a general property of all superconductors in tunnel contact. (A.G.W.)

36868 EJECTION OF ELECTRONS FROM SUPERFLUID HELIUM SURFACE BY ANNIHILATION OF QUANTIZED VORTEX RINGS. Cunsolo, S.; Dall'Oglio, G.; Maraviglia, B.; Ricci, M. V. (Univ., Rome). Phys. Rev. Lett., 21: 74-5(July 8, 1968).

An experiment is described which shows that single negatively charged vortex rings annihilate at the free surface of liquid helium. Annihilation means that the whole energy of the vortex ring inside the liquid is transferred to the electron, which is ejected from the liquid into the vapor. The experiment is performed at 0.4°K. The experimental cell is schematically represented. (M.H.R.)

36869 SUPERCONDUCTIVITY OF VERY THIN ALUMINIUM FILMS. Walmsley, D. G.; Campbell, C. K.; Dynes, R. C. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 46: 1129-32 (May 1, 1968).

This note presents the results of superconductive tunneling measurements which show that very thin (50 to 100 Å) aluminum films exhibit a unique superconducting energy gap. The temperature dependence of this gap is BCS-like, and the ratio of the gap magnitude — as extrapolated to T = 0°K ($2\Delta(0)$) — to the observed transition temperature, T_c, remains close to the usual BCS value of 3.52 k. The effect of crystallite size on deviations from BCS results is also discussed in relation to experimental observations. (auth)

36870 EFFECT OF AC IMPEDANCE ON DC VOLTAGE–CURRENT CHARACTERISTICS OF SUPERCONDUCTOR WEAK-LINK JUNCTIONS. McCumber, D. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 39: 3113-18(June 1968).

Because the Josephson pair current in a weak-link superconductor junction is a nonlinear parametric function of junction voltage, the ac impedance seen by the junction influences both the response time to changes in bias and the dc voltage–current characteristics. The first effect is obvious; the second, considered here, has not been generally recognized. Both are relevant to device design. Two special cases which illustrate the basic principles involved are worked out in detail; they correspond, respectively, to ac capacitive and inductive loading. The results partly explain differences in the dc voltage–current characteristics of plane-parallel and point-contact junctions. (auth)

36871 MAGNETIZATION OF SYNTHETIC FILAMENTARY SUPERCONDUCTORS. B. THE DEPENDENCE OF THE CRITICAL CURRENT DENSITY ON TEMPERATURE AND MAGNETIC FIELD. Watson, J. H. P. (Corning Glass Works, N. Y.). J. Appl. Phys., 39: 3406-13(June 1968).

Measurements of the magnetization of cylinders of synthetic high-field superconductors were made as a function of magnetic field and temperature. The superconductors were made by impregnating porous glass with indium. The porous glass can be characterized by the pore diameter; the critical field and the transition temperature depend strongly on the pore diameter. Assuming a critical-state model, the current density J_c was calculated from the magnetization versus field curves and was found to be of the form $J_c = A - CB$ for magnetic fields B less than 0.3 of the critical field. In greater fields, J_c is almost independent of field. A and C depend upon temperature. For values of the ratio T/T_c between 0.9 and 0.5, A increases linearly with decreasing temperature. Several samples with different pore sizes have been measured; no systematic dependence on pore size was found. (auth)

36872 ELECTRICAL CONDUCTIVITY AND SUPERCONDUCTIVITY IN THE γ PHASE OF THE Tl–Te SYSTEM. Juodakis, A.; Kannewurf, C. R. (Northwestern Univ., Evanston, Ill.). J. Appl. Phys., 39: 3003-7(June 1968).

Two methods for the preparation of single crystals of the γ phase of the Tl–Te system, Tl_5Te_3, are described. An analysis

of electrical resistivity data on both single-crystal and polycrystalline material over the temperature range 4.2° to 500°K and thermal conductivity data on polycrystalline material over the temperature range 77° to 360°K indicates metallic behavior. Typical electrical characteristics at 300°K are: resistivity 2.5×10^{-4} Ω·cm, carrier concentration 1.5×10^{22}/cm^3, and mobility 2.0 cm^2/V·sec. A transition to the superconducting state was observed at 2.19°K; this transition was studied as a function of magnetic field strength. The existence of superconductivity in the γ phase is generally compatible with predictions for the occurrence of superconductivity in degenerate semiconductors and semimetals with positive Hall coefficients. (auth)

36873 GROUND-STATE AND LOW-EXCITED PROPERTIES OF LIQUID ^{3}He CALCULATED WITH A TWO-BODY POTENTIAL. Burkhart, Theodore W. (Stanford Univ., Calif.). Ann. Phys, (N. Y.), 47: 516-64(May 1968).

Although scattering phase shifts reveal that the interaction of two free ^{3}He atoms with the momenta and spins of quasi particles in liquid ^{3}He is attractive, the experimental spin-averaged effective quasi-particle interaction (F^s) defined in Landau's Fermi-liquid theory is repulsive in liquid ^{3}He. To understand the role of many-body effects in the repulsive interaction, the bulk properties of liquid ^{3}He were calculated using the Bethe–Goldstone method and using Goldstone perturbation theory. The compressibility yields a value for F_0^s, the angular average of F^s. The potential used in the calculations is a hard-core square-well potential adjusted to approximate the phase shifts of the de Boer 6–12 potential. The properties computed with the Bethe–Goldstone method give good agreement with experiment for effective masses m_4^* between 1.0 and 1.4 times the true mass. In liquid ^{3}He three-body correlations are expected to be important. Using techniques developed for nuclear matter by Bethe and his coworkers, all two and three-body Goldstone diagrams were estimated. The properties computed are in very good agreement with experiment. Since the net three-body energy is obtained in the calculation by adding repulsive and attractive contributions much larger in absolute value than their sum, these numbers should not be taken too seriously. Three-body diagrams contribute most of the binding energy in our calculation. The three-body repulsive energy is about 60% of the two-body repulsive energy. One describes qualitatively how the Pauli principle helps suppress the contributions of higher clusters. As particles are added to a self-bound many-body system or a system under pressure, the binding energy per particle decreases. Those particles originally present are rearranged into an "excited" state. In both the Bethe–Goldstone and Goldstone-perturbation-theory calculations, the rearrangement contributions are large enough to make the calculated effective quasi-particle interaction repulsive. (auth)

36874 SUPERCONDUCTING PERFORMANCE OF DIFFUSION-PROCESSED $Nb_3Sn(Cb_3Sn)$ DOPED WITH ZrO_2 PARTICLES. Benz, M. G. (General Electric Research and Development Center, Schenectady, N. Y.). Trans. Met. Soc. AIME, 242: 1067-70 (June 1968).

The superconducting performance of diffusion-processed Nb_3Sn is influenced by its microstructure. High isotropic transverse current density may be achieved in this material by a process which forms a precipitate of ZrO_2 within the Nb_3Sn. (auth)

36875 AC LOSSES NEAR THE LOWER CRITICAL FIELD OF SUPERCONDUCTING NIOBIUM. Linford, R. M. F.; Rhodes, R. G. (Univ. of Warwick, Coventry, Eng.). Phys. Status Solidi, 28: K63-5(July 1, 1968).

Curves showing the ac dissipation in monocrystalline Nb as a function of applied magnetic field are presented. At low fields the single crystal is more dissipative than the polycrystalline rod. At a value of H_{max} close to the lower critical field, the single-crystal dissipation curve shows a sudden sharp increase while that of the polycrystal shows a much more gradual rise over several hundred Oersteds. These results are discussed briefly in relation to the absence of an abrupt transition at the lower critical field in most of the published work on Nb. (A.G.W.)

36876 CRITICAL-FIELD MEASUREMENT OF SUPERCONDUCTING TUNGSTEN AS RELATED TO THE CERIUM-MAGNESIUM-NITRATE TEMPERATURE SCALE. Black, William C. Jr. (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 21: 28-31 (July 1, 1968).

Measurements of the critical magnetic field curve of tungsten are presented and analyzed to determine the consequences of Abraham and Eckstein's proposed correction to the magnetic temperature scale for powdered cerium magnesium nitrate. The qualitative shape of the tungsten critical-field curve and the derived normal-state electronic specific-heat parameter γ favor a considerably smaller temperature correction than that suggested by Abraham and Eckstein. (auth)

36877 MOTION OF QUANTIZED FLUX LINES IN HARD SUPERCONDUCTORS IN THE PRESENCE OF TIME-VARYING MAGNETIC FIELDS. Gandolfo, David A. Philadelphia, Temple Univ., 1967. 107p.

Thesis.

The results of experiments in three related areas are presented. They include measurements of (1) the effective resistivity ρ_{eff} that characterizes the mixed state during the transmission of small magnetic-field steps, (2) the field interval between flux jumps in a rapidly varying field, and (3) the temperature increase that precedes a flux jump. The effective resistivity is observed when, under the influence of a small magnetic-field step the flux bundles begin to move away from the pinning sites but do not become completely unpinned. The sample remains essentially in the critical state during transmission of the field steps. For two NbTi samples ρ_{eff} was found to be in the range 10^{-12} Ω-cm $< \rho_{eff} < 10^{-10}$ Ωcm. It was found to increase as either the size of the field step (for a fixed rise time) or the background field was increased. Of the two samples the one with larger critical current density exhibited smaller ρ_{eff}. Because of its strong dependence on the nature of pinning sites ρ_{eff} will be a useful quantity in the study of these sites. In another series of experiments flux jumps occurring at regular intervals were observed in a NbTi sample in superimposed ac and dc fields. In a background field of 10 kOe, Δh decreased linearly with h from 890 Oe at 7×10^3 Oe/sec to 490 Oe at 3.5×10^5 Oe/sec; Δh is the difference between the field at the surface of the sample and that deep within the sample when the flux jump occurs. Similar behavior but with smaller Δh was observed in a background field of 20 kOe. The decrease in Δh with increasing h is consistent with Kim's analysis of power dissipation by a changing magnetic field. Values of Δh obtained from the present experiment are considerably smaller than that calculated from the theory of Swartz and Bean thus indicating a need for extension of the theory to the case of rapidly varying fields. Flux jumps in a pressure-sintered Nb_3Sn sample were observed in a third series of experiments. The sample was brought into the critical state by a slowly increasing dc field then heated by a small-amplitude ac field until a single complete flux jump occurred. The data permit one to calculate the hysteresis losses (after an expression by Bean) and from these the steady-state temperature increment ΔT that the sample may sustain before a flux jump occurs. ΔT was observed as a function of the difference H-H′ between dc fields at the outer and inner surfaces of the sample. ΔT decreased strongly as H–H′ increased, typical values being 3.2×10^{-2} deg for H–H′ = 7.2 kOe and 1.0×10^{-3} deg for H–H′ = 11.1 kOe. The results are consistent with the often made observation that flux jumps occur more readily in the low-field regime where large-field gradients and therefore large current densities are realized. ΔT calculated from a theoretical estimate by Anderson and Kim was found to lie within the range of the present experimental values. (Disser. Abstr.)

36878 ORIGIN OF SUPERCONDUCTIVITY. Krebs, H. (Univ., Stuttgart). Z. Naturforsch., 23a: 332-3(Feb. 1968). (In German).

The occurrence of superconductivity appears to be connected with the simple requirement that the electrons of a band have the possibility of moving in at least one direction without crossing plane or conical atomic nodal surfaces. This hypothesis is arrived at from a consideration of the bonding relationships in superconducting compounds. (auth)

Plasma and Thermonuclear Physics

36879 (AED-C-03-19) PLASMA PHYSICS INDEX. EXPERIMENTAL AND THEORETICAL PLASMA PHYSICS. Volume 3, No. 4. Hilsenbeck, D. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 196p. Dep.

A listing of 307 articles on various aspects of plasma physics is presented. Subject and author indexes are included. (M.O.W.)

36880 (N-68-16284) PLASMA PHYSICS ABSTRACTS, JANUARY 1, 1966–DECEMBER 31, 1967. Montgomery, David C.; Gurnett, Donald A. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). 14p. (NASA-CR-91239). CFSTI.

This bibliography consists of 26 recent references, most of them with abstracts. These references represent plasma physics publications from the University of Iowa during the above period which are considered relevant to research conducted within a NASA program. (STAR)

Confinement and Heating of Plasma

36881 (RISO-171) DRIFT WAVES IN A PARTLY IONIZED PLASMA. Oester, Flemming (Danish Atomic Energy Com-

mission, Risoe. Research Establishment). Jan. 1968. 16p. Dep.

A dispersion relation for the "drift" waves is obtained. Terms taking into account momentum exchange between charged particles and neutrals extend earlier results to the case of partly ionized plasmas. The dispersion relation is solved numerically for the case of a Q-machine plasma in which a neutral gas is introduced. The effects of the neutrals on the maximum growth rate and on the corresponding wavelength parallel to the magnetic field are discussed. (auth)

36882 (UCID-15334) IGNITION OF A PLASMA UNDERGOING BOHM DIFFUSION. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). May 27, 1968. Contract W-7405-eng-48. 11p. Dep. CFSTI.

Plasma parameters are found where the toroidal plasma can be sustained by the fusion reaction products while the diffusion rate is 15 to 30 times slower than the Bohm rate. A closed confinement geometry is proposed in the form of a polygon where long straight sections are connected with short toroidal sections. (M.O.W.)

36883 (UCRL-70681) MIRROR CONFINEMENT AND ITS OPTIMIZATION. Post, R. F. (California Univ., Livermore. Lawrence Radiation Lab.). May 20, 1968. Contract W-7405-eng-48. 39p. (CONF-671127-4). Dep. CFSTI.

From International Conference on Plasma Confined in Open-Ended Geometry, Gatlinburg, Tenn.

With the elimination of gross instabilities an accomplished fact, the further optimization of mirror confinement mainly hinges on satisfying two requirements: (1) adequate suppression of high-frequency wave-particle instabilities, and (2) minimization of enhanced end losses associated with the ambipolar potential. There is reason to believe that satisfactory solutions to both of these requirements can be found, by taking advantage of the topology and flexibility of open-ended systems. In such systems the basic problem is one of controlling the low-energy end of the ion energy spectrum, since both wave-particle instabilities and ambipolar ion losses are traceable to this class of particles. In this paper, the stabilizing effects of modifying ion distribution functions by the addition of "warm" plasma components are considered. The modes considered are (1) the high-frequency loss-cone convective mode and (2) the loss-cone drift cyclotron mode. It is shown that in high-mirror-ratio systems these two important modes should be strongly stabilized by the addition of a few percent of Maxwellian warm plasma ions with mean energies small compared to those of the contained ions. Some of the practical problems of creating such a situation are discussed. (auth)

36884 (UCRL-70869) DECAY MODES OF A DENSE PLASMA IN A MAGNETIC WELL. Coensgen, F. H.; Cummins, W. F.; Ellis, R. E.; Nexsen, W. E. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). June 20, 1968. Contract W-7405-eng-48. 18p. (CONF-680805-5). Dep. CFSTI.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

Energetic deuterium plasmas of $\beta \approx 5\%$ are formed in an open-ended magnetic well system using the techniques of plasma injection and magnetic compression. Containment in the quasi-dc field following compression is studied. Under ordinary vacuum wall conditions there are rapid plasma losses, accompanied by rf signals at ion-cyclotron frequencies, ω_{ci}. This activity is tentatively identified as the ion-ion instability due to a "double humped" ion energy distribution. The loss has been suppressed by forming gas-free Ti surfaces throughout the chamber. Under these latter conditions, it was also shown that interchange instabilities are suppressed by the minimum-B field for densities as high as 5×10^{13} cm^{-3}. The D^+ energy distribution as derived from analysis of charge-exchange fast atoms extends from 2 to 50 keV and, following the initial containment phase, remains essentially unchanged with time. The mean ion energy of 8 keV derived from the distribution is in good agreement with the ion temperature deduced from the measured density and prompt neutron flux. The fact that the reaction rate decays as n^2 is further evidence that the energetic D^+ ions are the primary plasma component. The decay rate is at all times substantially greater than that expected from ion-ion scattering, and thus is indicative of anomalous losses. Sporadic bursts of particles through the mirrors as well as fluctuations near ω_{ci} and harmonics give direct evidence of cooperative effects at densities above 2×10^{12} cm^{-3}. The density history is divided into three periods: After compression, the decay proceeds exponentially with a characteristic lifetime $\tau \approx 200$ μsec down to a density near 1.5×10^{13} cm^{-3} where the decay rate abruptly decreases so that τ increases to approximately 400 μsec. At densities $\leq 2 \times 10^{12}$ cm^{-3} the decay rate decreases markedly, so that this density remains nearly constant for periods of several hundred μsec. Two or more such periods may occur, separated by periods of rapid loss so that the density history in the third period has a steplike appearance. The transition between the first and second periods appears to mark the disappearance of a strong early instability which is thought to be the ion-ion mode first discussed by Dory, Guest, and Harris. Losses in the second period and between the flat sections of the third period appear in part to arise from multicomponent instabilities involving double-humping effects associated with the presence of impurity ions. (auth)

36885 ADIABATIC END LOSS FROM A θ PINCH. Morse, Richard L. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 11: 1558-61(July 1968). (LA-DC-9308).

Collisionless end loss of high β plasma from a θ pinch is estimated from a self-consistent z-dependent equilibrium. The effectiveness of a given vacuum mirror ratio is shown to increase with β and an instability is shown to exist in the mirror region. (auth)

36886 MAGNETIC SHIELDING OF CURRENT FEEDS IN PLASMA CONTAINMENT SYSTEMS. Burkhardt, L. C.; DiMarco, J. N.; Hammel, J. E.; Henson, R. M.; Karr, H. J. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-3ng-36. Phys. Fluids, 11: 1562-5(July 1968). (LA-DC-9155).

Experimental tests of the effectiveness of the magnetic shielding of current leads or supports in the form of linear dipoles are described. Results show that this technique may be useful in experimental plasma confinement devices. (auth)

36887 FIRST- AND SECOND-ORDER CORRECTIONS TO THE MAGNETIC MOMENT FOR LINEAR MULTIPOLES. Howard, James E. (Univ. of Wisconsin, Madison). Phys. Fluids, 11: 1569-71(July 1968).

The first- and second-order terms in the magnetic moment series have been calculated explicitly for a linear multipole field, using Gardner's general formulas. Computer results show that μ_2 is most important for orbits which stay close to a field line. (auth)

Diagnostics of Plasma

Refer also to abstracts 36134 and 36823.

36888 (N-68-16527) ADDITIONAL DEVELOPMENT OF A PROBE TO MEASURE VELOCITY DISTRIBUTIONS IN THE EXHAUST OF STEADY STATE PLASMA ACCELERATORS. Final Report. Liebing, L. (General Dynamics/Convair, San Diego, Calif.). Nov. 1967. Contract NAS1-7286. 25p. (NASA-CR-66550; GD/C-DBE-67-022). CFSTI.

The principle of operation of the probe, the mathematical treatment of the data, and the physical sources of error are discussed in detail. Problems related to the probe's application in the MPD arc plasma and their solution are presented. The result is a new probe with new measuring equipment. The velocity data is acquired through the measurement of the time of flight of the ions between an electrical plasma shutter and an ion collector. (auth) (STAR)

36889 PLANE ELECTROMAGNETIC WAVE DIFFRACTION ON TWO PARALLEL RADIAL NON-UNIFORM CIRCULAR PLASMA CYLINDERS. Ivanov, E. A.; Moshinskii, A. V. Dokl. Akad. Nauk BSSR, 12: 197-201(Mar. 1968). (In Russian).

A rigid solution was carried out of problems on the diffraction of plane electromagnetic waves of the TM type on two parallel infinitely long plasma cylinders with radial nonuniform concentration of the electrons of the plasma. The waves drop in direction, forming a right angle with the axis of the cylinder. The solution of the problem is found through the Hertz electric vector under the assumption that the plasma electrons are the source of the secondary waves outside and within the cylinder. The plasma electrons appear in the form of systems of immobile electric dipoles. Formulas were introduced and they can be used for the calculation of the radiolocation cross section of the system of plasma cylinders examined. (tr-auth)

36890 MEASUREMENT OF THE ELECTRON TEMPERATURE IN GASES BEHIND SHOCK WAVES BY MICROWAVE THERMAL IRRADIATION. Basharinov, A. E.; Lobastov, Yu. S.; Testov, V. G. Radiotekh. Elektron., 13: 499-505(Mar. 1968). (In Russian).

The electron temperature behind incident shock waves in argon and behind reflected shock waves in air, nitrogen, and argon was measured. The shock waves were created in a diaphragm shock tube at pressures of 0.5, 1.0, 2.0, 3.0, 5.0, 10.0, and 15.0 mm Hg. The electron temperature was measured by radiometric methods. The measured values of the temperature are in satisfactory agreement with the calculated values for equilibrium conditions. (tr-auth)

36891 PHOTOELECTRONIC ATTACHMENT FOR MEASURING PLASMA TEMPERATURE. Kukonin, V. E. (Minsk Inst. of Heat and Mass Transfer). Inzh.-Fiz. Zh., 14: 890-4(May 1968). (In Russian).

A photoelectronic attachment for measuring plasma temperature by the relative intensity of spectrum lines with time resolution of the order of 5×10^{-4} sec is described. The measurements of the copper lines $\lambda_1 = 5133$ Å and $\lambda_2 = 5105$ Å showed that temperature oscillations in a plasma jet present a stationary random process with the normal law of distribution. (auth)

36892 DETERMINATION OF NEUTRAL-ATOM DENSITY IN A HIGHLY IONIZED DECAYING HYDROGEN PLASMA. Forman, Peter R.; Kunkel Wulf B. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Fluids, 11: 1528-31(July 1968). (UCRL-17177(Rev.)).

A photoabsorption technique in the vacuum uv region is used to measure the density of atomic hydrogen in a decaying, highly ionized hydrogen plasma as a function of time and position. The plasma is formed in a metal cylinder with a strong axial magnetic field by a powerful pulsed cross-field discharge that takes the form of an axially propagating ionization front. It is found that during the discharge a fraction of the gas is driven to the boundaries forming a layer of increased neutral density which later relaxes back into the plasma by diffusion. In the interior, the plasma is initially highly ionized and the atom density builds up as the ion density decreases. The rate is consistent with predictions based on the collisional–radiative recombination model. (auth)

36893 THEORY AND MEASUREMENTS FOR ION COLLECTION BY A SPHERICAL PROBE IN A COLLISIONAL PLASMA. Self, S. A.; Shih, C. H. (Stanford Univ., Calif.). Phys. Fluids, 11: 1532-45(July 1968).

Following a discussion of existing probe theories for a collisional plasma, a new theory is given for ion collection by a spherical probe in a collisional plasma which goes over to the collisionless theory of Allen et al., at low pressures and the continuum theory of Su and Lam at high pressures. Numerical results are given in a form suitable for interpretation of experimental data. Experimental probe studies in the positive column (1 cm diameter) of a He discharge in the pressure range 0.05 to 0.4 torr are described and the use of the electron and ion saturation methods for determining plasma concentration compared with one another and with a microwave cavity perturbation method. The limitations of the theories and experimental methods are discussed. (auth)

36894 MEASUREMENT OF ELECTRON TEMPERATURE USING RELATIVE LINE INTENSITIES OF ARGON II. Kribel, R. E. (Univ. of California, San Diego, La Jolla). Phys. Fluids, 11: 1579-80(July 1968).

The electron temperature in an argon magnetoplasmadynamic arc has been measured at 1.1 ± 0.3 eV. The magnitude of the transition probability for the 4847.9 Å line of Ar II is much closer to the theoretical value than reported in earlier measurements. (auth)

36895 MICROWAVE DIAGNOSTICS OF INHOMOGENEOUS PLASMAS. Estin, Arthur John. Boulder, Colo., Univ. of Colorado, 1967. 131p.

Thesis.

Microwave techniques have been used for a number of years in plasma diagnostics, particularly in the measurement of electron densities. Only in a small number of cases, however, has any attempt been made to find electron density profiles, the usual diagnostic procedure being an averaging over the volume of the plasma. In this work, the term "differential diagnostics" is introduced and is defined to mean "the measurement of some property of a plasma at some particular point and time relative to that property at some other point and time." Microwave techniques using surface waves are described for space differential diagnostics and microwave interferometry is applied to both space and time differential diagnostics. In each case, an integral inversion procedure permits unfolding a curve fitted to a series of phase-shift measurements to deduce the desired electron density profile. A helix is used both to propagate a surface wave and to form a diffusion boundary for a 2-torr neon plasma. The profile of the electron density near the boundary is investigated and the results are compared with the most nearly applicable idealized theory. Both theory and experiment indicate that the sheath effects extend far deeper than the usually assumed Debye distance—more nearly 10 to 20 times the Debye distance. The theory is developed to demonstrate that a dielectric-lined waveguide will sustain a surface wave and is applicable to space differential diagnostics. A configuration is proposed that is useful for examination of plasmas with a cylindrical cross section. The calculations takes into account the perturbation caused by a glass wall which contains the plasma. Interferometry is one of the most versatile microwave diagnostic tools, but has heretofore been used only in a relatively gross semi-quantitative way. In this work, the accuracy limitations of plane-wave interferometry are examined and extended, and precise measurement techniques are developed. An Abel inversion formula is derived which permits a transverse interferometric scan of a cylindrical plasma column to be unfolded, yielding the radial density profile. A Michelson interferometer setup is used to determine the degree to which a given microwave antenna is usable in the plane-wave approximation required for diagnostics. A standard gain V-band horn, both with and without absorbing material as attenuative padding, was investigated. The results indicate that the usual criterion of placing the plasma at least a quarter of a Rayleigh distance away from the horn is usually too conservative, but that multiple reflections must be suppressed. These principles of precision interferometry were applied to the measurement of the dielectric constant of seven slabs of "rexolite" of different thicknesses. The results indicate that, first, a major error can be caused by unwanted reflections, and second, that the the first-order correction technique developed in this work does indeed reduce this error by a large factor. (Disser. Abstr.)

36896 DETERMINATION, BY MEASUREMENT OF THE ELECTRIC CONDUCTIVITY, OF THE MEAN TEMPERATURE OF A LAMINAR JET OF NITROGEN PLASMA. Fauchais, Pierre; Moreau, Michel; Manson, Numa (Faculte des Sciences, Poitiers, France). Compt. Rend., Ser. A and B, 266: 1110-13(Apr. 22, 1968). (In French).

The measurement of the electric conductivity of a nitrogen plasma jet in the laminar regime, with the aid of an assembly composed of two loops of a high-frequency circuit (50 MHz), permits the determination of the mean temperature (6,000 to 10,000°K) and the equivalent diameter of this jet considered as homogeneous. The results obtained agree with those of spectroscopic measurements to ±8%. (tr-auth)

36897 SPECTROSCOPIC DETERMINATION OF THE STATE OF A HIGH-PRESSURE PLASMA. Mayes, Terrill Wayne. Nashville, Vanderbilt Univ., 1967. 124p.

Thesis.

Using the method of Kerr cell shuttered spectroscopy, the temperature and free electron density of a plasma produced in an electric shock tube has been determined as a function of distance and time by measuring the widths and relative intensities of spectral lines emitted by the plasma. Upon considering the criteria for the establishment of local thermodynamic equilibrium (LTE) in the plasma, it was found that the free electron densities obtained in this experiment are large enough to expect the plasma to be in a state of LTE. A comparison of the temperatures obtained from different chemical elements and ionization stages is consistent with the presence of LTE. With the plasma being in a state of LTE, the density and pressure of the plasma were calculated from the Boltzmann equation and the ideal gas law using the measured values of relative intensity of the spectral lines along with the calculated values of temperature and free electron density. The calculated profiles of pressure, density, and temperature are then compared to those predicted by blast wave theory, whereupon large discrepancies are observed with a large temperature excess over the values predicted by Rankine–Hugoniot theory for the shock front being a major difference. This disagreement is attributed to (1) a turbulent mixing at the shock front, (2) the difference in the initial conditions of the energy release specified by the theory and the conditions actually present, (3) a possible preheating of the ambient gas ahead of the shock front by absorption of ultraviolet resonance radiation from the arc discharge, and (4) radiative and other energy losses. The trajectory of the shock front is predicted quite well by the theory if a modification is made to take account of the difference in the initial conditions of the theory and the experiment. Even though blast wave theory fails to predict the correct magnitudes for the pressure, density, and temperature in this experiment, the shapes of the experimental density and pressure profiles are observed to be similar to those predicted by the theory. The experimental temperature profiles are also observed to be similar to theory in that both show the temperature rising behind the shock front. This similarity is not as good as for the pressure and density, however, because the theoretical temperature rises much more rapidly than the experimental data. (Disser. Abstr.)

36898 ABSORPTION OF ELECTROSTATIC WAVES BY PLASMA ELECTRONS. Decker, James Frederick. New Haven, Yale Univ., 1967. 139p.

Thesis.

Measurements are described of the energy exchange between a plasma column and a periodic structure coaxially surrounding the column. The structure imposes an eleven wavelength (quasi)

electrostatic standing wave upon the plasma with essentially one value of wave vector $\underline{k}$ and continually variable frequency ω. When the plasma can be considered collisionless, the power absorption by plasma electrons is a resonant process. Similarities between this absorption process and Landau damping of electron plasma waves are evident, and the experimental results support the ideas of Landau damping. Because of the dependence of the frequency dependent power absorption on $\partial f_0/\partial v$, the method has use as a diagnostic tool for determining the electron velocity distribution in low density plasmas. Application of "strong" rf fields to a drifting electron plasma produces a nonlinear deformation of the time averaged distribution. Measurements of this deformation compare favorably with a quasilinear calculation for weak nonlinear behavior. (Disser. Abstr.)

36899 HIGH-SPEED MEASUREMENT METHODS IN PLASMA PHYSICS. Andelfinger, C. pp 980-1035 of Kurzzeitphysik. Vollrath, K.; Thomer, G. (ed). Wien, Springer-Verlag, 1967. (In German).

A bibliographic review is made of the high-speed measurement methods in plasma physics. Examples are given of electrical measurements, high-speed photographic methods, interferometric methods, microwave methods, spectroscopic methods, measurement of energetic particles and radiation, and measurements with laser radiation. (J.S.R.)

36900 ION CURRENT EXTRAPOLATION FOR LANGMUIR PROBE MEASUREMENTS. Stern, W. (Institut fuer Gasentladungsphysik, Griefswald, Ger.). Rev. Roum. Phys., 13: 137-53 (1968). (In German).

The extrapolation of the ion saturation current used for the separation of the ion and electron currents in Langmuir probe measurements leads, especially at low electron temperature and relatively high carrier densities in the negative glow of low-pressure glow discharges, to the establishment of a too great excess in fast electrons with respect to the Maxwell distribution (electron groups). For relatively high negative probe voltages, the dependence of the ion saturation current on the probe voltage can be represented in approximation by a quadratic relation. A complete description of the pattern of the probe characteristic lines in the ion saturation range and the determination of the axial pattern of the carrier density in the negative glow was possible with the help of probe theoretical calculations. The application of a lattice probe avoids the ion current extrapolation and permits the diagnostics of electron groups of higher energy. (tr-auth)

36901 WIDTHS AND SHIFTS OF ARGON-II LINES IN A PULSED ARC. Barnard, A. J.; James, H. G.; Neufeld, C. R. (Univ. of British Columbia, Vancouver). Can. J. Phys., 46: 1083-6(May 1, 1968).

The spectrum of a high-density arc plasma was photographed with a 15 μs exposure time. The widths and shifts of 17 Ar-II lines were measured. While most lines have small blue shifts, the 4104 and 4278 Å lines have substantial red shifts. These two lines are also twice as wide as the other lines. (auth) (Canada)

36902 DEVICE FOR FORMING REPLICA IMAGES OF PARTICLE DISTRIBUTIONS IN A PLASMA STREAM. Coensgen, Frederic H.; Cummins, William F.; Nexsen, William E. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,379,880. Apr. 23, 1968.

A device is described for recording replica images of particle distributions in a plasma or charged particle stream. The device includes a semi-transmissive element for attenuating the atomic particle stream, an electrically polarized grid arranged to selectively repel undesired charged particles from the attenuated stream, and a scintillator screen disposed to intercept the resultant particle stream electrostatically accelerated through a light excluding means, producing a light image replica of the stream. (AEC)

36903 INFLUENCE OF NONELASTIC COLLISIONS UPON TRANSFER PHENOMENA IN HOT GASES. Dubner, V. M.; Komarovskaya, N. V. (Inst. of High Temperatures, Moscow). Inzh.-Fiz. Zh., 14: 857-64(May 1968). (In Russian).

The classical approximation of the collision theory is applied to the study of contribution of nonresonance inelastic collisions of atoms and molecules into transport coefficients. The main attention is given to transitions between the upper levels attached to continuous spectra. The generalized estimation is obtained for the value of the total cross section of nonelastic collision, and some limited cases are studied. (auth)

36904 ENERGIES AND QUANTITIES OF IONS IN LASER-PRODUCED METAL PLASMAS. Paton, B. E.; Isenor, N. R. (Univ. of Waterloo, Ont.). Can. J. Phys., 46: 1237-39(May 15, 1968).

Mean kinetic energies and abundances of ionic species from plasmas of Al, Cu, and Au produced by focused Q-switched ruby laser light were measured. Electrostatic and time-of-flight methods are used. General agreement is found with existing theory regarding the mean energies of the different ionic species but the relative abundances display anomalies. (auth) (Canada)

Kinetics of Plasma

36905 (MATT-580) FLUCTUATION PROPERTIES OF STRONGLY-TURBULENT MICROWAVE-HEATED STELLARATOR PLASMAS. Bol, K.; Ellis, R. A. Jr. (Princeton Univ., N. J. Plasma Physics Lab.). June 1968. Contract AT(30-1)-1238. 76p. Dep. CFSTI.

Resistive microwave heating has been used on the Etude stellarator to obtain plasmas with the same density and temperature ($n \approx 10^{13}$ cm^{-3}, Te $\approx$ 25 eV) as the usual ohmically heated ones, but without contamination by runaway electrons or large parallel currents. Measured spatial correlation properties of the density fluctuations in these strongly turbulent plasmas conform in the main to those predicted for the most unstable electrostatic modes of a simple slab plasma. These modes are primarily electron drift waves, destabilized over a wide range of wave numbers by resonant electron interactions and to a lesser extent by resistivity. What may be a gravitational ballooning mode is observed at low values of the l = 3 helical stabilizing field, but it progressively disappears at higher field values while simultaneously the axial correlation lengths shorten. Compressional, probably hydromagnetic, vibrations of the whole plasma column are observed at the upper end of the frequency range ($\omega < 2\pi$ MHz), but remain as yet unexplained. Although rotational transform and magnetic field shear could not be varied independently, the shortening of the axial correlation lengths observed with increasing helical field is more easily explained as the result of shear than of transform angle. A striking consequence of increasing the helical field is that the transport of plasma by the fluctuations ultimately vanishes (in a straight section of the discharge tube) although the amplitude of the fluctuations in the density gradient is undiminished. (auth)

36906 (N-68-15521) PROPAGATION AND DISPERSION OF HYDROMAGNETIC AND ION CYCLOTRON WAVES IN PLASMA IMMERSED IN MAGNETIC FIELDS. Semiannual Status Report, July 15, 1967-January 14, 1968. Friedrich, Otto M. Jr. (Texas Univ., Austin. Plasma Dynamics Research Lab.). Jan. 15, 1968. 54p. (NASA-CR-92583; SASR-10). CFSTI.

Experimental and theoretical investigations of ion cyclotron waves and related wave phenomena in magnetoplasma are discussed. Experimental facilities for the generation and detection of harmonic ion cyclotron waves and the fast wave associated with the ion cyclotron wave are described. Results are presented from the initial tests of a preionization device of the reflex PIG type. An analysis is presented of the Stix coil as a means of exciting quasi-static ion cyclotron waves. In the first approximation, coupling to the wave is shown to be a secondary effect, as the primary fields of the Stix coil do not couple directly to the wave. An outline is presented of the formalism for calculating the coupling coefficients of the Stix coil for quasi-static ion cyclotron waves assuming cold plasma boundary conditions. Experimental investigations of propagation of the fast hydromagnetic wave are presented. It is shown that the observed propagation in bands can be explained in terms of higher-order transverse and azimuthal modes and that, with this assumption, the predicted waveguide cutoff is in agreement with the experimentally observed cutoffs. (auth) (STAR)

36907 (N-68-16007) PARAMETRIC COUPLING BETWEEN DRIFT WAVES. Hai, F.; Rowberg, R.; Wong, A. Y. (California Univ., Los Angeles. Dept. of Physics). Oct. 1967. 11p. (NASA-CR-92566; R-17). CFSTI.

Preliminary experimental results are reported on the nonlinear phenomenon of parametric coupling between drift waves in a plasma. This coupling involves the excitation of a low mode number drift wave by a "pump" drift wave at a higher mode in a cesium plasma of a single ended Q device. A probe biased at about the plasma potential provides pump wave excitation and a Langmuir probe monitors the drift wave. Wave amplitudes of both the pump wave and the excited wave increase with increased voltage of the oscillator. Results show that the threshold for parametric excitation of a mode frequency depends upon damping associated with this mode. (STAR)

36908 (N-68-16067) MAGNETOPLASMADYNAMIC THRUSTOR RESEARCH. Final Report. Bennett, S.; Enos, G.; John, R.; Powers, W. (Avco Corp., Lowell, Mass. Avco Space Systems Div.). May 21, 1967. Contract NAS3-8907. 148p. (NASA-CR-72345; AVSSD-0272-67-RR). CFSTI.

Radiation- and water-cooled MPD thrustors were operated in a range of power of 10 to 100 kW, in the I_{sp} range 1000 to 5000 seconds, using ammonia as the propellant. Parametric studies were made of the effects of configuration, field strength, ambient pressure, propellant composition, and current-on performance. A life test was made of a radiation-cooled thrustor at the 3000-second, 36-kW level. (auth) (STAR)

36909 (N-68-16396) A CRITICAL REVIEW OF THE MAGNETOPLASMADYNAMIC (MPD) THRUSTOR FOR SPACE APPLICATIONS. Nerheim, Noble M.; Kelly, Arnold J. (Jet Propulsion Lab., Pasadena, Calif.). Feb. 15, 1968. Contract NAS7-100. 118p. (NASA-CR-93139; JPL-TR-32-1196). CFSTI.

A comprehensive review of the published performance data and proposed acceleration mechanisms of the magnetoplasmadynamic (MPD) plasma accelerator has been made to estimate its capacity to operate in a spacecraft propulsion system. The ability of the MPD thrustor to perform a specific space mission is compared with that of the ion engine for a Mars-orbiter mission. This comparison is based primarily on the reported performance data, however, other required characteristics, such as lifetime, reliability, compatibility with a solar electric power supply, and the associated weight requirements of the power-conditioning equipment, are discussed. The best results have been obtained with lithium, ammonia, and hydrogen. The definition and attainment of the proper test environment remain one of the biggest problems. No reliable method exists to determine whether or when entrainment occurs. In spite of the uncertainties associated with the MPD engine, it may be concluded that the ion engine operates more efficiently than the MPD, with the possible exception of operation at a specific impulse of less than 300 s. If the MPD thrustor is to compete with the ion engine, the weight savings gained with the MPD must be enough to offset the ion engine's higher overall efficiency. (auth) (STAR)

36910 (N-68-16507) TRAPPED MODES IN PLASMA SLABS AND CYLINDERS. Weil, A. J. (Pennsylvania State Univ., University Park. Dept. of Electrical Engineering). Feb. 1, 1968. 143p. (NASA-CR-93148; SR-314). CFSTI.

An analysis of trapped modes is given for uniform, cold magnetoplasma slabs and rods. The full set of Maxwell's equations is used, and arbitrary magnetic field strength is allowed. Two dispersion relations are obtained for the slab, characterizing symmetric and antisymmetric field solutions. The general dispersion relation for the plasma rod geometry is obtained, simplified using an analogy with the slab case, and analyzed. For each dispersion relation, three kinds of interior waves are found: (1) waves which damp as you move toward the center; (2) oscillating or body waves; and (3) damped oscillating waves. The field characteristics of the waves are analyzed for the slab geometry and for the dipolar modes of the plasma rod. A new approximation, the "one-wave" approximation is introduced and discussed. Dispersion curves and field solutions are given for $\Omega = .5\omega_p$ and $\Omega = 1.5\omega_p$, and for different thicknesses. (auth) (STAR)

36911 (N-68-16681) CALCULATION OF TOTAL THERMAL CONDUCTIVITY OF IONIZED GASES. Ahtye, Warren F. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). Nov. 1967. 15p. (NASA-TM-X-60857). CFSTI.

The suitability of the Boltzmann equation for calculating transport coefficients of partially ionized gases is discussed. Analytical and experimental investigations are cited to show that it can be used as a starting point to calculate the total thermal conductivity. The Chapman–Enskog solution of the Boltzmann equation is used to derive an expression for the total thermal conductivity, composed of three parts—the translational, reactive, and thermal diffusive components. The reactive and thermal diffusive components are explicitly expressed in terms of the multicomponent and thermal diffusion coefficients. Effects of higher-order Sonine expansion terms are examined for the various transport coefficients. The first three orders of the Sonine expansion terms are required for the accurate calculation of the translational thermal conductivity, whereas only the first two orders are sufficient for the calculation of the multicomponent and thermal diffusion coefficients. These diffusion coefficients are then used to calculate the reactive and thermal diffusive components of the total thermal conductivity of hydrogen, nitrogen, and argon at conditions where the reactive component is at a maximum. (auth) (STAR)

36912 (N-68-16784) FOCUSED DISCHARGE FROM PULSED PLASMA GUNS. Cheng, Dah Yu (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). Nov. 11, 1967. 14p. (NASA-TM-X-60854). CFSTI.

High-speed blobs of hydrogen plasma are focused by means of a coaxial gun having a convergent barrel in the shape of a frustum of a cone. The focal point is at the virtual vertex. The plasma area at the focal point is about $1/100$ the breech area, and about $1/4$ the muzzle area. About one milligram of cold gas introduced through a fast-acting valve initiates an electric discharge at the breech between the conical barrel and a cylindrical cathode rod on the axis, the barrel initially being evacuated to a pressure of 10^{-7} torr. Plasma and discharge propagate to the muzzle where the plasma is expelled into vacuum. When the barrel is emptied of plasma, the discharge extinguishes. Image-converter camera pictures indicate a muzzle velocity not less than 5×10^7 cm/sec. Impulse measurements from target discs at the plasma focus suggest an average velocity of about 2×10^8 cm/sec, and an energy flux of about 200 MW/cm^2. Of the 5000 joules initially available in the capacitor-bank driver about 1200 joules are transferred to the plasma. (auth) (STAR)

36913 (N-68-17070) CORRELATION OF TRANSIENT SPECTRA WITH PERFORMANCE IN COAXIAL PLASMA GUNS. Michels, Charles J.; Hettel, Henry J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 32p. (NASA-TN-D-4385). CFSTI.

The time-varying spectra of an argon plasma in a coaxial gun were measured. Two gun geometries were investigated, both with argon propellant. The transient spectra were obtained by viewing the plasma spectra in the exit plane of a polychromator with an electronic image converter camera used as a streak camera. Frame and streak camera views and magnetic probes were also used to study the discharges occurring in the guns. The transient spectrum of each gun was completely different. The geometry which exhibits relatively clean argon spectra showed good performance. It operated internally crowbarred. The performance correlates well with both earlier theory and experiments and extends previous data. In contrast, the geometry which exhibited contaminant spectra showed poorer performance which does not agree with theory or past experimental data. This geometry operated in the multiple-moving-discharges mode. The discharge spectra showed no argon lines, and the contaminant lines were those from a pyrex gas baffle just upstream of the gas ports. The influence of the gas baffle on performance accounts for discrepancies with earlier data (both experimental and theoretical). The two different geometries of the guns served to demonstrate the usefulness of transient spectra diagnostics as an added tool in ascertaining when theory can correctly be applied to a given gun. A description of a two-channel transient voltage digitizer is given. The digitizer is used to record dynamically gun voltage and current at the rate of 5 million samples per second. It digitizes these samples and punches them on paper tape for data reduction by a conventional high-speed computer. (auth) (STAR)

36914 (N-68-22708) RADIATION FROM SOURCES IMMERSED IN A PARTLY IONIZED GAS. Connolly, Denis J. (Case Inst. of Tech., Cleveland, Ohio). [1968]. 55p. (NASA-CR-94598; A-41). CFSTI.

Using a three-fluid model, wave equations are developed for the disturbances due to current or hydrodynamic force sources in a plasma. The formal solutions to the wave equations are obtained for an elementary current source. The power radiated from the source is given in terms of these solutions, and, for the special case in which the electrons are much hotter than the other two constituents, the radiated power is determined in detail. (auth) (STAR)

36915 (N-68-22847) EXPERIMENTAL INVESTIGATION OF THE FUNDAMENTAL MODES OF A COLLISIONLESS PLASMA. Final Report, March 10, 1964–October 31, 1967. Malmberg, John H.; Bhadra, Dilip K.; Book, David L.; Moore, C. David; Pearlstein, L. Donald; (and others) (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 23, 1967. Contract NAS7-275. 129p. (NASA-CR-94430; GA-8375). CFSTI.

This report summarizes results of experimental and theoretical research to investigate propagation of electron cyclotron waves in a collisionless plasma and to investigate the origin and effects of low-frequency noise in the plasma. The theoretical work concentrates on the application of the linear theory of plasma waves to geometries encountered experimentally, where the size is finite, and the density is a function of position. A perturbation method is derived for predicting the Landau damping (or growth) of electron cyclotron waves in terms of the electron velocity distribution function and the potential and density profiles. The dispersion, damping, and beam-induced growth of the waves have been measured as a function of the plasma parameters and the plasma boundary conditions. The results are compared to theory. An electronic device for analyzing composite interferograms composed of two or more damped sine waves is described. Measurements on the origin and effects of low-frequency noise in the plasma (10 to 300 kc) are presented. Methods are given for re-

ducing the low-frequency noise which result in a simultaneous order-of-magnitude reduction in anomalous diffusion of the plasma (auth) (STAR)

36916 (N-68-22887) PERIODIC, SMALL-AMPLITUDE SOLUTIONS TO THE SPATIALLY UNIFORM PLASMA CONTINUITY EQUATIONS. Roth, J. Reece (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1968. 43p. (NASA-TN-D-4472). CFSTI.

The coupled set of first-order nonlinear differential equations $\dot{x} = C_0 + C_1 x + C_2 y + C_3 xy + C_4 x^2 + C_5 y^2$ and $\dot{y} = A_0 + A_1 x + A_2 y + A_3 xy + A_4 x^2 + A_5 y^2$ are solved by an approximate method which gives y(t) in closed form for the particular case in which the variables x and y vary periodically in time, the coefficients C_i and A_i are real, and the peak-to-peak variation of x is of small amplitude relative to the mean value of x. The peak-to-peak amplitude of y, however, is not necessarily small compared with the mean value of y. These equations are a generalized form of Volterra's problem of two conflicting populations, in which x is the population density of the prey, and y is the population density of the predator, or vice versa. Similar equations may also be derived from the spatially uniform neutral and charged-particle continuity equations in the field of plasma physics. These equations then describe relatively low-frequency oscillations in the number density of electrons and neutral atoms in a partially ionized plasma. (auth) (STAR)

36917 (ORO-3647-3) OBLIQUE HYDROMAGNETIC SHOCK WAVES. Robson, A. E.; Sheffield, J. (Texas Univ., Austin. Center for Plasma Physics and Thermonuclear Research). June 1968. Contract AT(40-1)-3647. 14p. (CONF-680805-6). Dep. CFSTI.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

An experiment is described in which shock waves are propagated in a magnetized hydrogen plasma with Alfvén Mach numbers up to $M_A = 5$ and at angles to the magnetic field, α from 90° to 40°. The plasma, of density $\sim 5 \times 10^{14}$ cm^{-3} and temperature ~1 eV is created in a pyrex chamber 45 cm diameter and 93 cm long by means of an oscillatory z discharge. The initial magnetic field is 500 to 1000 G. A curved magnetic piston is driven into the plasma by exciting a rapidly rising θ current in a single-turn loop of short axial length arranged round the tube on its midplane. A curved shock front propagates ahead of the piston in the manner of a bow wave. Magnetic and electric probes are used to study the development and structure of the shock front. On the midplane the front has the monotonic field jump typical of propagation perpendicular to the field, but for propagation at an angle to the field a radically different structure is seen. Ahead of the main jump in field and density there is a large amplitude, circularly polarized oscillation which is identified as a high-frequency Alfvén ("whistler") wave propagating at the same speed as the shock. The results are compared with numerical computations of shock structure using hydromagnetic equations. To account for the observed structure, it is necessary to invoke collisionless effects. (auth)

36918 PROPAGATION OF THE PERTURBATION AND NOISE ALONG THE ELECTRON CURRENT, PERFORATING THE PLASMA OF LOW-VOLTAGE ARCS. Gvozdover, S. D. Radiotekh. Elektron., 13: 490-8(Mar. 1968). (In Russian).

The macroscopic equation of the plasma–beam system was modified suitable to conditions in low-voltage arcs with glowing cathodes and was applied to the explanation of the phenomena in the scattering layer. It was assumed that the grouping of the current electrons, which are modulated by shot noise, was the principal reason. Tests were made to prove the conclusion that the periodic structure of the noise along the current was caused by the fluctuations with the frequency above the plasma frequency and the formation of scattering layers was caused by fluctuations of the frequency below the plasma frequency. Formulas for the thickness of the layer, the relaxation time of the electrons of the plasma, length of the noise waves, and the dielectric permeability were derived. (tr-auth)

36919 ON THE THEORY OF THE FLOW FIELD IN A WALL-STABILIZED ARC WITH TRANSVERSE MAGNETIC FIELD. Seeger, G. (Elektrophysikalisches Institut, Munich). Z. Angew. Phys., 25: 23-9(June 5, 1968). (In German).

The flow field in a wall-stabilized arc under the influence of an external transverse uniform magnetic field is investigated. Assuming a given temperature distribution, expressions for the stream function, velocity and vorticity are derived from the momentum equation by means of the biharmonic Green's function. Analytic expressions for a current filament are determined. The results are reproduced graphically and discussed for different displacements from the center. The pressure distribution and the resulting forces of pressure and friction on the wall are treated. It is shown how the influence of the density field can be taken into account by means of an iteration procedure. (auth)

36920 EXPERIMENTS ON THE INTERACTION OF A PLASMA JET WITH A MAGNETIC FIELD. Ragaller, K. (Elektrophysikalisches Institut, Munich). Z. Angew. Phys., 25: 31-37(June 5, 1968). (In German).

The interaction of a MPD jet with an axisymmetric magnetic cusp-field is investigated. A maximum effect occurs at field strengths of about 100 G. By a small water-cooled Hall-probe the three components of the magnetic field were measured locally in the jet. Therefrom the electric current density distribution is derived. It turns out that the aximuthal current which causes the interaction is concentrated in a narrow cone-shaped layer which can also be identified by its strong radiation. This current sheet confines a region of relative high magnetic field which is built up due to a compression of the applied field by the plasma flow. The current distribution of the jet engine is also evaluated to estimate the influence of Hall currents. A theoretical model for the current sheet is proposed which, however, cannot explain all observed features. (auth)

36921 INSTABILITY OF SYNCHROTRON RADIATION. Fung, P. C. W. (Univ. of Montreal. Stanford Univ., Calif.). Can. J. Phys., 46: 1073-81(May 1, 1968).

In a system of isotropic relativistic electrons which is embedded in a cold ambient magnetoactive plasma, the growth rate of synchrotron radiation at wave normal angle $\theta = 90°$ is derived by means of the classical kinetic approach. It is shown that the result is identical with that obtained from the quantum treatment. Two errors occurring in the literature of synchrotron radiation are pointed out. The growth rate is computed for the case of monoenergetic electrons as an example. (auth) (Canada)

36922 TRANSIENT RADIATION IN A PLANE STRATIFIED DISPERSIVE MEDIUM. I. HALF-SPACE CONFIGURATION. Ott, Edward; Shmoys, Jerry (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). Can. J. Phys., 46: 1059-71(May 1, 1968).

A similarity principle is derived for a class of transient diffraction problems in cold, lossless, isotropic plane stratified plasmas. The similarity principle is utilized to obtain an exact closed-form solution to the problem of a magnetic current source whose density is a delta function (in space and time) situated either in or above a homogeneous plasma half-space. This solution is interpreted in terms of rays and group velocity. An independent solution to the half-space problem is also obtained using asymptotic techniques. Exact and asymptotic solutions are compared and discussed. (auth) (Canada)

36923 INFINITE CYLINDRICAL ANTENNA IN A COMPRESSIBLE PLASMA. Nguyen, D. T. (Univ. of Auckland, New Zealand). Can. J. Phys., 46: 1311-21(June 1, 1968).

A theoretical model of an infinite cylindrical antenna, fed by a delta-function generator and immersed in a compressible, isotropic, lossless plasma, is considered in detail. A modal solution is found for the associated waveguide problem inside the antenna; apart from the slow mode, the waveguide modes are grouped into three sets: optical, acoustic, and hybrid modes. The current wave on the outside wall of the antenna is separated into its components: the familiar electromagnetic wave, the "transverse electroacoustic" wave which is due to the axial oscillation of electrons near the gap, and the slow surface wave. These wave components have been calculated numerically using an IBM 1130 digital computer. It is found that the electromagnetic as well as the "transverse plasma" waves have a logarithmic singularity at the gap. It is also found that at a relatively large distance from this gap the first component decays as $1/|Z|$, while the second component decays very rapidly to zero. (auth) (Canada)

36924 PRODUCTION AND PROPAGATION OF PLASMOIDS IN A NONLINEAR ALFVEN WAVE. Wells, Daniel R. (Univ. of Miami, Coral Gables, Fla.); Norwood, Joseph Jr. Phys. Fluids, 11: 1582-4(July 1968).

A variational theory of hydromagnetic dynamic equilibria is applied to plasmoids produced in a conical theta pinch immersed in a magnetic guide field. The solutions correspond to nonlinear Alfvén waves which trap and transport plasma. (auth)

36925 ELECTRON DISTRIBUTION IN AN ELECTROSTATIC SHOCK. Tidman, D. A.; Fu, J. H. M. (Univ. of Maryland, College Park). Phys. Fluids, 11: 1580-2(July 1968).

The consequences of resonant interactions between electrons and ion waves in a turbulent shock wave are discussed. (auth)

36926 INCIDENT AND REFLECTED IONIZING SHOCK STRUCTURE. Presby, Herman M.; Meehan, Richard J. (Columbia Univ., New York). Phys. Fluids, 11: 1487-9(July 1968).

Separation of the electron density transition from the current

sheet and the luminous peak has been observed with ionizing waves in an electromagnetic shock tube. Upon reflection of the shock, coalescing waves and macroscopic turbulence are seen. (auth)

36927 HARMONIC GENERATION FROM AN IONIZED GAS SLAB. Vogel, R. W. (Univ. of South Florida, Tampa); Desloge, E. A. Phys. Fluids, 11: 1490-6(July 1968).

The effect of collisions on harmonic generation in an ionized gas slab through which an electromagnetic wave is passing is considered. The gas is assumed to be slightly ionized with electron–neutral molecule collisions dominating. An approximate distribution function is assumed which contains five undetermined parameters. Boltzmann's transport equation is used to obtain the appropriate kinetic equations governing the behavior of these parameters. The kinetic equations are coupled to Maxwell's equations and a Fourier solution in time is used. The ionized gas slab is stratified into a series of individually homogeneous laminae and the equations are solved. The first harmonic transmitted and third harmonic generated power are calculated and plotted versus input power for several collision cross sections. (auth)

36928 PROPAGATION OF CIRCULARLY POLARIZED ELECTROMAGNETIC WAVES IN A FINITE TEMPERATURE ELECTROMAGNETOPLASMA. Hsieh, H. C. (Univ. of Michigan, Ann Arbor). Phys. Fluids, 11: 1497-1505(July 1968).

The dispersion relation for circularly polarized electromagnetic waves in a warm two-component plasma subject to parallel static electric and magnetic fields has been derived from the linearized coupled Boltzmann–Maxwell equations with the collision frequency assumed to be independent of the particle velocity. The effect of a weak longitudinal electrostatic field, E_0, on the propagation characteristic of the right- and left-hand circularly polarized waves in an isothermal electron–proton plasma is examined in detail and illustrated numerically for a conveniently chosen set of the system parameters. For the right-hand polarized wave the electrostatic field effect is found to be significant for a wave with frequency ω in the vicinity of the electron cyclotron frequency $\omega_c \equiv (eB_0/m)$. For example, for a given ω and $\delta \equiv (eE_0/mc\omega) > 0$ an increase in δ, or in E_0, leads to the increase or decrease of the attenuation constant α, of the wave according to whether $Y \equiv (\omega_c/\omega) < 1$ or $Y > 1$. Moreover, for $Y = 1.10$, when $\delta < 0$ (i.e., when E_0 and the wave vector k are oppositely directed) α increases with $|\delta|$. On the other hand, when $\delta > 0$ an increase in $|\delta|$ causes α to decrease and for a sufficiently large value of δ, α may become negative so that the wave may experience a spatial growth. (auth)

36929 SOME INVESTIGATIONS OF NONLINEAR BEHAVIOR IN ONE-DIMENSIONAL PLASMAS. Dawson, J. M. (Princeton Univ., N. J.); Shanny, R. Contract AT(30-1)-1238. Phys. Fluids, 11: 1506-23(July 1968). (MATT-568).

Numerical experiments on a one-dimensional electron plasma were used to obtain an insight into nonlinear plasma phenomena. Three experiments were carried out. The first dealt with the damping of a large-amplitude wave which is found to be much stronger than that predicted by linear theory. A rough theory for the damping is presented. The second experiment examined mode–mode coupling. Quantitative agreement was found with theory after precautions were taken to avoid other effects, in particular, "trapped" particles. A rough theory for "trapping" is given. The third experiment examined the weak turbulence produced by a small bump in the tail of the distribution function, and present theory appears inadequate to describe this behavior. After initial growth, the unstable modes fluctuate on a time scale of $10\omega_p^{-1}$. The bump in the tail of the velocity distribution flattens out in a short time $(20\omega_p^{-1})$, and then evolves into a hot Gaussian tail which coexists with the main plasma for a long time ($\gtrsim$1000 ω_p^{-1}). Particles in the tail have been observed with four times the initial average energy of the beam electron. A discussion of the physical effects which appear to be involved in this experiment is given, and estimates of their importance for three-dimensional plasmas are presented. (auth)

36930 DISTRIBUTION FUNCTION OF ENERGETIC PARTICLES SCATTERED BY A PLASMA. Bornatici, M.; Engelmann, F. (EURATOM–CNEN, Rome). Phys. Fluids, 11: 1546-7(July 1968).

It is shown that the distribution of the deflection angles of energetic particles, which travel through a homogeneous and stationary quiescent plasma in the absence of external fields, is Gaussian, if the deflections are small. (auth)

36931 EFFECTS OF ELECTRON INTERACTIONS ON THE PLASMA THERMAL CONDUCTIVITY. Levinsky, E. S.; Rand, S. (Univ. of California, San Diego, La Jolla). Phys. Fluids, 11: 1548-9(July 1968).

The application of longitudinal wave emission and absorption, to the determination of the thermal conductivity of a fully ionized Lorentz gas, is extended phenomenologically in order to include the effects of electron–electron interactions. A simple modification thereby obtained yields good agreement with the results of previous calculations, which were found by means of formal expansions of the Boltzmann equation about the collision term. (auth)

36932 GENERATION AND MOTION OF PLASMOIDS IN A MAGNETIC FIELD WITH MIRRORS. Jones, W. B.; Miller, R. D. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Fluids, 11: 1550-7(July 1968).

Plasmoids have been generated in a low-powered theta pinch and accelerated into a uniform longitudinal dc magnetic guide field. The guide field was used to guide the plasmoids into a region between two colinear dc mirrors. The motion of the plasmoids was studied by means of detector coils arranged to measure the diamagnetic effect of the plasmoids. It was found that the plasmoids move in the guide field with uniform velocity, are reflected efficiently by properly chosen mirror fields, and are apparently stable for an observed period of 25 μsec. A pulsed gating coil was arranged in one of the dc mirrors so as to weaken the mirror and allow plasmoids to be gated through the mirror by pulsing the gating coil in the correct phase. Attempts to capture plasmoids between the two mirrors resulted in the plasmoids losing their structure after two reflections between the mirrors and then beginning to expand along the guide field lines. Some measurements were made to determine microscopic characteristics of the plasmoids. (auth)

36933 SHOCK PROPAGATION IN SPHERICALLY SYMMETRIC EXPONENTIAL ATMOSPHERES. Lutzky, M.; Lehto, Delbert L. (Naval Ordance Lab., Silver Spring, Md.). Phys. Fluids, 11: 1466-72(July 1968).

Computer calculations have been made of the propagation of the shock from an explosion at the origin of a spherically symmetric, exponential, ideal-gas atmosphere. A generalization of Sachs scaling has been devised which allows a very convenient systematization of the pressure–distance curves, and which shows that, for a suitable normalization, these curves are straight lines throughout a significant range of yield, distance, and degree of atmospheric inhomogeneity. This technique is also used to investigate the validity of modified Sachs scaling, an approximate method of generating pressure–distance curves for an inhomogeneous atmosphere from the known results for a homogeneous atmosphere. It is found that modified Sachs scaling yields results which deviate from the hydrodynamic code calculations by at most 20% in the weak shock regime. This result is essentially independent of yield. Some comments are made on the applicability of these methods to the problem of shocks from explosions in horizontally stratified, real-gas atmospheres. (auth)

36934 BOUNDARY BETWEEN A PLASMA STREAM AND A DIPOLE MAGNETIC FIELD. Rubin, A. G. (Air Force Cambridge Research Lab., Bedford, Mass.). Phys. Fluids, 11: 1566-8(July 1968).

The boundary region between a plasma stream and a dipole magnetic field with dipole axis normal to the flow is investigated by means of probes. Simultaneous measurements of the transverse electric field, particle density, magnetic field, and rate of change of magnetic field are made. Oscillations in the electric and magnetic fields are found in the megacycle range. The electric-field oscillations take place in the region of the particle-density gradient, and the magnetic-field oscillations are located at the magnetic-field gradient. The electric-field oscillations are thought to be ion–acoustic or magneto–acoustic waves excited by a streaming instability. (auth)

36935 KINETIC EQUATION FOR A WEAKLY TURBULENT PLASMA TAKING COLLISIONS INTO ACCOUNT. Hatori, Tadatsugu (Tokyo Univ.). Phys. Fluids, 11: 1584-6(July 1968).

Under the assumption that both the nonlinear coupling of waves and wave-particle scattering can be neglected, the collision term is only the sum of the quasilinear term and the nonstationary collision term for the weakly unstable homogeneous plasma. (auth)

36936 ELECTROMAGNETIC WAVE PROPAGATION IN INHOMOGENEOUS MAGNETO PLASMAS. Rao, Surabhi Sathyanarayan. Lawrence, Kan., Univ., of Kansas, 1966. 172p.

Thesis.

Approximate solutions of waves have been of great interest in the investigation of propagation problems in inhomogeneous and anisotropic media. Several contributions to the theory of electromagnetic wave propagation in plasmas have appeared in the literature, however, the problem of obtaining satisfactory wave solutions for the most accurately determined tensor properties of the

plasma in large measure still remains unsolved. A brief account on the subject is given and various approximate solutions are discussed. Fourth order differential equations governing the wave propagation in inhomogeneous magnetoplasma are derived for the case of normal and oblique incidence. The differential equations are then solved by using asymptotic series approximation method with k = w/c free space wave number as expansion parameter. The fourth order differential equations are found very convenient to obtain higher order asymptotic approximations with imposed arbitrary static magnetic field. A general asymptotic equation is derived and it is shown that any higher order asymptotic approximation can be found from the general asymptotic equation. Particular cases are discussed and they are found to agree with the classical WKBJ approximation. Numerical results based on our asymptotic approximations are presented for a layer of isotropic and nonisotropic plasma. It is found that higher order asymptotic approximations improved the classical WKBJ approximations. The convergence of asymptotic series is observed in the numerical results presented by taking a few terms of the series for large k. Approximate solutions of the type presented in this investigation can be very useful for the solution of waves in inhomogeneous plasmas when the exact solutions to the problem are not available. Wave propagation in inhomogeneous magnetoplasma with finite compressibility of the medium is discussed. A three-dimensional electric field wave equation governing the wave propagation in the above medium is derived using dyadic notation. The refractive index equation with arbitrarily directed static magnetic field is derived for vertically incident plane wave, and it is found to obey a nonlinear differential equation. Particular cases are discussed and results are compared with previous results. Potential equations for inhomogeneous and anisotropic media are derived and it is shown that one needs to solve one vector potential wave equation. The scalar potential can be found consequently. Particular cases of harmonic time variation and static fields are discussed and Poisson's equation for a general medium is found. It is finally noted that results obtained for potentials can be used for radiation and propagation problems in magneto-ionic medium by defining appropriate dielectric tensor. Formulation of a problem in terms of scalar and vector potentials may be found useful to separate physically the action of the current and charge in producing the electromagnetic field. (Disser. Abstr.)

36937 MAGNETOPLASMA WAVE DEVICE. Bowers, R.; Houck, J. R. (to United States Atomic Energy Commission). U. S. Patent 3,388,321. June 11, 1968.

This patent relates to apparatus for measuring the strength and polarity of a high strength magnetic field by providing an alternating current signal whose frequency is proportional to the strength of the magnetic field in one direction. In one embodiment, a solid is inserted in the field at low temperatures to produce self-oscillating magnetoplasma waves corresponding in frequency to the strength of the field. (AEC)

36938 SOLUTIONS OF THE LENARD–BALESCU EQUATION FOR DRIFTED PLASMAS. Sinz, Kurt Hartmut Paul Hermann. College Station, Tex., Texas A and M Univ., 1967. 133p.

Thesis.

The usefulness of one-dimensional plasma models is often questioned because of the absence of lateral effects that are considered to be important in three dimensions. However, one-dimensional models are much more tractable and should yield much information about what to expect from more complicated three-dimensional descriptions especially when higher order kinetic equations are employed. To this end an investigation of the one-dimensional Lenard–Balescu equation was carried out when an external electric field is included in the formalism. Numerically exact solutions of these equations were performed with displaced Maxwellian distributions as initial conditions. The interaction term was seen to measurably affect the distributions during one plasma period. The strength of the Lenard–Balescu interaction term was found to increase with initial displacement until a maximum separation was reached beyond which the initial conditions could not satisfy the differential equations. It is conjectured what effect a three dimensional analog to these properties would have on the results of other researchers. Quantities observed were drag, diffusion and Landau damping. Also displays are given of the functions that contribute to the Lenard–Balescu interaction term. (Disser. Abstr.)

36939 INVESTIGATION OF RADIO-FREQUENCY PLASMOID DISCHARGES. Kregel, Mark Douglas. University Park, N. Mex., New Mexico State Univ., 1967. 101p.

Thesis.

A proposed model of the dark sheath observed in low-pressure rf discharges in electronegative gases is developed. This model is based on the concept of delayed emission of excited ions allowing these ions to be "swept" from certain regions of the discharge where the static electric field is large before radiative de-excitation can occur. Spatial luminosity measurements on O_2^+ and O^* show that the luminosity dip occurs only for O_2^+, a result consistent with the proposed model. In addition, numerical solutions of the Tonks–Langmuir plasma equation, modified for the case of negative ions, have yielded the necessary form for the static electric field, a form that has previously been observed experimentally. A classification scheme based on the electron plasma frequency has been used to classify various modes of the low pressure rf discharge according to their physical appearance and behavior. Measurements of the Doppler widths of the emission lines from O_2^+ and N_2^+ show that these positive ions have essentially the same line width as would neutral particles at room temperature, and that the effective rotational temperature of N_2^+ is room temperature. In addition positive ion energy profile measurements made at the wall of a low pressure rf discharge have revealed that the technique used to couple rf power into a low pressure rf discharge makes significant differences in the behavior of the discharge. (Disser. Abstr.)

36940 SCATTERING OF ELECTROMAGNETIC WAVES BY TURBULENT, WEAKLY IONIZED PLASMAS. Kroell, W. (Ruhr Univ., Bochum, Ger.). Z. Naturforsch., 23a: 19–25 (Jan. 1968).

The scattering of a plane, monochromatic electromagnetic wave by the fluctuations of the dielectric constant of a turbulent weakly, ionized plasma is investigated on the basis of the statistical theory of locally isotropic turbulence. The effects of collisions on the fluctuating dielectric constant of the electrons are taken into account. The spectral density determining the scattering cross section is related to the structure functions of the fluctuations of the electron concentration and the temperature. These structure functions are calculated from the transport equations with the use of methods developed in the statistical theory of strong turbulence. (auth)

36941 TRANSPORT COEFFICIENTS OF DEGENERATE PLASMA. Lampe, Martin. Berkeley, Calif., Univ. of California, 1967. 142p.

Thesis.

An improved nonrelativistic calculation is presented for thermal conductivity, electrical conductivity, and thermoelectric coefficient of a plasma of highly degenerate weakly coupled electrons and nondegenerate weakly coupled ions. The calculation is based on the quantum Lenard–Balescu transport equation. Dynamic shielding in the random phase approximation is treated correctly, and both electron–ion (ei) and electron–electron (ee) collisions are included for thermal conductivity. Previous workers have argued that ee collisions are negligible, because the Pauli exclusion principle limits their effect to $(kT/E_F)^2$ less than that of ei collisions, where k is the Boltzmann constant, T is temperature, and E_F is the Fermi energy. This argument is shown to be incorrect for thermal conductivity when particle interactions are weak and long-range (as in a plasma); ee collisions do in fact reduce thermal conductivity by 15 to 30% for temperatures of about 10^8 K and densities of 10^{24} to 10^{30} electrons 1 cc, appropriate to the cores of red giant stars. These effects are insignificant, however, for metals and semiconductors at terrestrial temperatures. Electrical conductivity and thermo-electric coefficient never depend significantly on ee collisions. (TSS) (Disser. Abstr.)

36942 SEPARATION OF VARIABLES IN EIKONAL EQUATION IN THE PROBLEM ON ELECTROMAGNETIC WAVE PROPAGATION IN A MAGNETOACTIVE PLASMA. Yashin, Yu. Ya. (Scientific Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 11: 491–502(1968). (In Russian).

There have been derived the relations valid for the coefficients of eikonal equation the full integral of which is obtainable by the method of separation of variables. Electromagnetic waves are assumed to propagate in a two-dimensional magnetoactive plasma in the geometrical optics approximation when the external magnetic field H_0 is oriented along one of the coordinate axes. As an example, the problem of propagation of waves in a plane perpendicular to H_0 when the medium properties vary in the same plane is considered. (auth)

36943 DIFFRACTION OF ELECTROMAGNETIC WAVES ON RADIALLY INHOMOGENEOUS PLASMA SPHERE AND CYLINDER. Permyakov, V. A. (Moscow Power Engineering Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 11: 531–42(1968). (In Russian).

The algorithm of numerical integration of the general differential equations is proposed. The problems of diffraction of electromagnetic waves on radially inhomogeneous plasma spheres and cylinders (for the cylinder only the two-dimensional problem is considered) are reduced to the solution of the above-mentioned equations. The latter are obtained as a power series at a quasi-

linear approximation of the character of dielectric permittivity variation. The results of numerical calculations of the back-scattering cross section of the inhomogeneous sphere are compared with those made in the approximation of a strongly inhomogeneous plasma and in a quasi-static approximation. The conditions for a perfectly conducting sphere instead of the inhomogeneous plasma one are estimated. (auth)

36944 DESCRIPTION OF ELECTRON TRANSPORT COEFFICIENTS OF PARTIALLY IONIZED PLASMA IN MAGNETIC FIELDS WITH THE INCLUSION OF INELASTIC COLLISIONS. Wilhelm, J.; Winkler, R. (Institut fuer Gasentladungsphysik, Berlin). Rev. Roum. Phys., 13: 115-20(1968). (In German).

A general representation of the electron transport coefficients was previously given with inclusion of inelastic collisions, but with neglect of Coulomb interactions. The expressions were generalized for the case of the presence of an external magnetic field. (J.S.R.)

36945 LEKTSII PO FIZIKE PLAZMY. (Lectures on Plasma Physics). Frank-Kamenetskii, D. A. Moscow, Atomizdat, 1968. 288p.

General aspects of plasma physics and simple engineering calculations are reviewed. Comprehensive data are included on thermodynamic plasma properties, equilibrium and stationary ionization, adiabatic and drift motion of charged particles, elementary hydrodynamic theory of wave propagation in cold and hot plasma, physical plasma kinetics, and its applications to plasma. 26 references. (R.V.J.)

36946 VELOCITY OF SHOCK WAVES IN CROSSED ELECTROMAGNETIC FIELDS. Uchida, Motokazu (Mechanical Engineering Research Lab., Tokyo). Jap. J. Appl. Phys., 7: 771-8(July 1968).

The velocity variations of shock waves in steady, crossed electromagnetic fields have been measured by using a T-shaped electromagnetically driven shock tube filled with helium at an initial pressure of 1 torr. Also the analysis concerning the velocity variations are made by the characteristic method including the electrical conductivity variation due to the change of the shock wave velocity and assuming that the magnetic Reynolds number is very small and that the Hall effect is negligible. The effect of finite magnetic Reynolds number on the velocity variation is estimated analytically. The effect is shown to be small. The measured variations of the velocity agree fairly well with those obtained analytically. (auth)

Production of Plasma

Refer also to abstract 36904.

36947 (WERL-3472-10) PLASMA PRODUCTION BY A HIGH-POWER Q-SWITCHED LASER. Quarterly Progress Report No. 1, February 1-April 30, 1968. Engelhardt, A. G. (Westinghouse Research Labs., Pittsburgh, Pa.). May 1, 1968. Contract AT(30-1)-3472. 5p. Dep. CFSTI.

During this period measurements were made of electron temperature and density in aluminum plasmas using Thomson scattering. The targets struck by the focused Q-switched laser beam were 75-μ-radius aluminum spheres. The retracting pedestal apparatus continues to operate reliably. The theoretical work has been partly concerned with the development and application of the nonlinear theory to experimental results and partly concerned with the thermokinetic or linear theory. (auth)

36948 CESIUM MHD ARC JET. Blackstock, A. W.; Fradkin, D. B.; Roehling, D. J.; Stratton, T. F. (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 39: 3201-9(June 1968).

A cesium-fueled magnetohydrodynamic arc jet was operated between 4 and 12 kW at magnetic field strengths up to 1000 G. Electrostatic probe, spectroscopic, and microwave measurements were made on the exhaust beam. Beam momentum was determined from the deflection of a downstream sieve. The magnitude and position of Hall currents were determined using magnetic-loop pickup coils. The overall arc voltage is a linear function of applied axial magnetic-field strength. The thrust is a linear function of the product of the arc current and applied axial magnetic-field strength, and is of a magnitude too great to be produced by the measured Hall currents. A partial theory is developed that describes the functional dependence of the arc voltage and thrust. Data are presented that show mass entrainment was present and that when the arc is operated with mass entrainment the exhaust velocity is predicted by the Alfvén "critical velocity." (auth)

36949 WALL STABILIZED ELECTRIC ARC WITH MAGNETIC ADJUSTABLE CHARACTERISTIC. Maecker, H.; Preibisch, H. (Electrophysikalisches Institut, Munich). Z. Angew. Phys., 25: 29-31(June 5, 1968). (In German).

An electric arc is described, which burns in a chamber built of alternating piled cascade plates with small, resp. wide diameter. A transverse magnetic field drives a vortex gas flow in the wide ranges which due to its cooling effect causes the voltage to rise while the cascade plates with small holes keep the arc near the center. If the magnetic field strength is made proportional to the arc current and if in addition a constant field for compensation is applied, then a steeply increasing and in wide regions adjustable characteristic results without elevation of the voltage itself. (auth)

36950 EXPERIMENTAL INVESTIGATIONS OF NORMAL IONIZING SHOCK WAVES. Levine, Leslie S. (Columbia Univ., New York). Phys. Fluids, 11: 1479-86(July 1968).

Experiments have been conducted on normal ionizing shock waves produced in a coaxial electromagnetic shock tube. Steady shock velocities were measured as a function of initial gas pressure, drive current, and applied axial magnetic field. The speeds agreed well with theoretical values. Measurements were made of the switch-on magnetic field, the upstream transverse electric field, and the density ratio across the front. The data all show that trans-Alfvénic shocks ($u_{A1f_0} < u_s \lesssim 3u_{A1f_0}$) exhibit Chapman-Jouguet behavior, with current flow in the shock front, and no separation of shock and drive currents. In contrast, super-Alfvénic shocks ($u_s \gtrsim 3u_{A1f_0}$) appear to be gas dynamic in nature. Spectroscopic measurements and shock-reflection studies demonstrated the presence of a nonluminous front and shock-heated gas preceding the luminous drive current. (auth)

Stability of Plasma

Refer also to abstract 36824.

36951 (N-68-15826) AN EXPERIMENTAL AND THEORETICAL INVESTIGATION OF TURBULENCE INSTABILITIES AT PLASMA MAGNETIC FIELD INTERFACES. Semiannual Report for Period Ending April 1967 and Final Report for Period Ending January 1968. Bostick, Winston H. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Jan. 1968. 22p. (NASA-CR-92518; SIT-P-206). CFSTI.

Experiments were conducted with probes and the plasma camera on plasma moving across a homogeneous magnetic field, and the results show that the parallel-to-B_0 plasma vortex structure can be extremely complex at low magnetic fields. At magnetic fields above 1000 gauss, the plasma assumes a much more regular shape and apparently rolls like a caterpillar tractor track as it moves across the field. It was also found that the firing of a two-wire button plasma gun into a magnetic field with a gradient produces not only a curved trajectory for the plasma, but the plasma ends up in a perpendicular-to-B_0 vortex structure. It was concluded that the data obtained show how minimum B works as a containment device: the trajectories of the blobs of plasma in the gradient fields are curved by $j \times B$ forces; the current loops of the current density j can be drawn in a semiquantitative way. (auth) (STAR)

36952 (UCRL-70866) CRITERIA FOR STABILIZATION OF ELECTROSTATIC MODES IN MIRROR-CONFINED PLASMAS. Berk, H. L.; Fowler, T. K.; Pearlstein, L. D.; Post, R. F.; Callen, J. D.; Horton, W. C.; Rosenbluth, M. N. (California Univ., Livermore. Lawrence Radiation Lab.). June 25, 1968. Contract W-7405-eng-48. 18p. (CONF-680805-3). Dep. CFSTI.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

Stabilization criteria for magnetic mirror-confined plasmas were investigated. The authors have (1) recalculated the critical lengths to include refinements in the analysis of wave-reflection processes, (2) taken into account the stabilizing effects of longitudinal magnetic field and density gradients on the resonant absolute modes, and (3) considered modifications of the collisional loss-cone distributions, primarily as a way of reducing the critical radius. The overall result of the various calculations is to yield more reliable stability criteria, and ones which permit a greater flexibility in the choice of parameters. (M.O.W.)

36953 (UCRL-70876) STABILITY OF E-LAYER AND PLASMA IN ASTRON CONFIGURATIONS. Benford, G.; Book, D. L.; Christofilos, N. C.; Fowler, T. K.; Neil, V. K.; Pearlstein, L. D. (California Univ., Livermore. Lawrence Radiation Lab.). June 21, 1968. Contract W-7405-eng-48. 16p. (CONF-680805-4). Dep. CFSTI.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

Reverse-field equilibria, stability of the layer, stability of the plasma, and the layer-plasma coupling are discussed. The result is an example configuration of a plasma of appreciable beta imbedded in an E layer, with many features favorable toward stability. (M.O.W.)

36954 EQUILIBRIUM AND STABILITY OF PLASMA IN AXIALLY SYMMETRIC TOROIDAL CONFIGURATIONS. Zueva, N. M.; Solov'ev, L. S. At. Energ. (USSR), 24: 453-9(May 1968). (In Russian).

Theoretical investigation of equilibrium and stability of plasma in axially symmetric systems of "Tokamak" type is carried out. The effect of toroidality and shape of the plasma torus cross section on the hydromagnetic stability is considered. Three equilibrium configurations of different shape of external magnetic surfaces cross section are investigated: elliptic, semi-elliptic and rectangular. It is shown that the stability of plasma in such systems essentially depends on the external magnetic surfaces cross section and on variation of magnetic field across the plasma cross section. In case of a quasi-homogeneous longitudinal magnetic field it is possible to obtain $J/I \sim 1/2$, $\beta = 8\pi p/B^2 \sim 1/2$, where J is the longitudinal plasma current and I is the current in the solenoid creating the longitudinal magnetic field. (auth)

36955 CROSS-STREAM INSTABILITY IN A PLASMA. Spero, Donald M.; Sen, Amiya K. (Columbia Univ., New York). Phys. Fluids, 11: 1524-8(July 1968).

A mixed hydromagnetic–electrostatic instability is found propagating perpendicular to the aligned magnetic field and electron streaming in a collisionless plasma. It is found that the growth rate may be comparable to that of the two-stream instability, and there are cases where ions are heated more than electrons. The finite temperature case is considered and thermal damping of the instability is demonstrated. (auth)

36956 COMPARATIVE STUDY OF PLASMA IN TOROIDAL QUADRUPOLE AND OCTOPOLE CONFIGURATIONS. Voorhies, H. G.; Ohkawa, T. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Fluids, 11: 1572-8(July 1968).

A comparison is made between the behavior of plasma in toroidal quadrupole and octopole configurations. The electron temperature is of the order 1 eV and the density 10^9 cm^{-3}. In the octopole configuration, the fluctuations are only observed outside the stability limit predicted by theory. However, such a stability limit cannot be found in the quadrupole configuration because fluctuations are observed throughout the plasma. All the fluctuations have zero wavenumber along the field lines. Waves can be transmitted inside the quadrupole separatrix, and a dispersion relation is measured and compared with the dispersion relation for a drift wave. (auth)

Thermonuclear Processes

36957 (FOA-4-4360-25) CALCULATION OF FUSION REACTION RATES USING AVERAGES OVER DEFORMED MAXWELLIAN DISTRIBUTIONS. Hoernqvist, N. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). May 1968. 22p. Dep.

Calculations are reported of fusion reaction rates with averages over the particle velocity distributions involved. Usually Maxwellian distributions were employed. The distribution function is assumed to be a Maxwellian with a deformation, simulating e.g., an energy peak. The relative effect of this deformation on the magnitude of the fusion reaction rate was investigated. The calculations were restricted to the case of fusion between deuterons and tritons. (auth) (Sweden)

Shielding

Refer also to abstract 37232.

36958 (AD-663570) MODELING RELATIONSHIPS IN NEUTRON TRANSPORT THROUGH DUCTS AND CAVITIES. Final Report, June 1964–September 1967 on Nuclear Radiation Shielding Studies. Diaz, Justo (Illinois Univ., Urbana). Sept. 1967. Contract N00228-66-C-0311. 30p. (NRSS-5). CFSTI.

If radiation reflection within a duct or cavity is treated by the usual albedo approximation, that is, on the assumption that radiation emerges from the wall at the same point at which it is incident, it is possible to establish modeling relationships between similar configurations differing only by a scale factor. The foregoing assumption is investigated, and it is found that the modeling relationships are approximately valid for fission neutrons as long as the linear dimensions are on the order of two and a half feet or more. This lower limit may be decreased if the effective reflection plane, which is always a few centimeters beneath the actual cavity interface, is utilized as the bounding surface of the duct or cavity. (auth) (USGRDR)

36959 (AI-Memo-64-152) A SIMPLIFIED MONTE CARLO APPROACH TO DEEP PENETRATION PROBLEMS. Levitt, L. B. (Atomics International, Canoga Park, Calif.). July 1964. 12p. (CONF-446-86). Dep. CFSTI.

From American Nuclear Society 10th Annual Meeting, Philadelphia, Pa.

A method of increasing the sampling efficiency in Monte Carlo calculations of thick shield penetration has been developed. The procedure alters the effective mean free path in such a way as to maximize the rate of convergence of the transmission probability. The approach is semi-empirical in nature and has been shown to be remarkably insensitive to geometry. The primary dependence appears to be on the nonabsorption probability at each collision, with secondary dependence on the distance to escape. The procedure is simple enough to permit its incorporation into existing Monte Carlo codes with a minimum of programming effort. (auth)

36960 (K-DP-3106) ANGLE DEPENDENT SPECTRA EMERGENT FROM SLAB SHIELDS-COMPARISON OF TWO DIMENSIONAL DISCRETE ORDINATES CALCULATIONS WITH EXPERIMENT. Mynatt, F. R.; Muckenthaler, F. J.; Stevens, P. N. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). [nd]. Contract W-7405-eng-26. 16p. (CONF-680601-24). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Slab shields composed basically of polyethylene, Pb, and U were exposed to a reactor beam source at the Tower Shielding Facility. Measurements of the angle-dependent leakage spectra of fast neutrons and high-resolution measurements of the radial dependence of the fast-neutron dose on the exit face of the slabs were made. Numerous calculations were then performed using the one-dimensional transport code ANISN and the two-dimensional discrete ordinates code DOT. Comparisons confirm that DOT is accurate in calculating the neutron transport. (A.G.W.)

36961 (N-68-10702) EXPERIMENTAL ELECTRON SHIELDING STUDIES. Jupiter, C.; Merkel, G. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 26, 1965. Contract NAS8-11304. 73p. (NASA-CR-89966; GACD-6844). CFSTI.

The experimental apparatus for measuring the electron penetration through thick slabs and for measuring the production of bremsstrahlung in thick slabs has been designed and assembled. The energy and angular spectra of electrons produced by the passage of 8.2- and 4.0-MeV electrons through various thick aluminum targets have been measured and compared to Monte Carlo calculations. A number of bremsstrahlung spectra measurements at 8.0 and 4.0 MeV have also been obtained. The design of a scattering chamber which will be the principal component in an experimental system to measure electron single interaction cross sections and single interaction bremsstrahlung production in thin targets has been completed. The present experimental setup allowed measurements using thick targets for electron and bremsstrahlung spectrum measurements for emission angles between 0 and 45 degrees. The new scattering chamber will allow an extension of these measurements to both thick and thin target electron and bremsstrahlung spectra for emission angles between 0 and 165 degrees. (auth) (STAR)

36962 (ORNL-TM-2209) SENSITIVITY OF GAMMA-RAY DOSE CALCULATIONS TO THE ENERGY DEPENDENCE OF GAMMA-RAY PRODUCTION CROSS SECTIONS. Yost, K. J.; Solomito, M. (Oak Ridge National Lab., Tenn.). May 24, 1968. Contract W-7405-eng-26. 17p. (CONF-680307-34). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The dependence of neutron-capture gamma-ray spectra on capture-neutron energy is of particular importance in the design of optimized reactor shields. The heretofore common practice of assuming that neutron-capture gamma-ray spectra are invariant to neutron energy is expected to be an unacceptable approximation for a shield material exhibiting strong resonance characteristics. The importance of adequately predicting gamma-ray yields from the capture of nonthermal neutrons of a particular shield is clearly a function of (a) the relative magnitudes of thermal and nonthermal neutron capture rates in regions of the shield contributing substantially to the surface capture-gamma dose rate, (b) the magnitude of the capture-gamma dose rate as compared to other sources of gamma radiation, and (c) the extent to which the capture-gamma dose rate is sensitive to changes in the shape of the capture-gamma spectrum. Each of these questions has been investigated in detail for three SNAP 10A core-laminated tungsten–lithium hydride shield configurations. Results indicate that, depending upon the shield in question, nonthermal neutron capture accounts for 90% to ~100% of the capture-gamma dose rate in tungsten, that capture gammas in tungsten constitute a far larger component of the surface gamma dose rate than do either primary or tungsten inelastic scattering gammas, and that capture-gamma dose sensitivity to the shape of the capture spectrum is strongly dependent upon shield configuration. (auth)

Solid-State Physics

Refer also to abstract 35839.

36963 (AD-664943) IMPURITY EFFECTS ON THE IONIZATION STATES OF F-AGGREGATE COLOR CENTERS IN SODIUM FLUORIDE. Chandra, Ashoka (Cornell Univ., Ithaca, N. Y. Materials Science Center). Jan. 1968. Contract Nonr-401(54). 218p. (MSC-TR-8; MSC-868). CFSTI.

Thesis.

The role of hydroxide and peroxide impurities on color-center properties in sodium fluoride were studied with several crystals grown with the Kyropoulous technique. The optical absorption in peroxide-doped samples consists primarily of three bands at 275 mμ, 235 mμ, and 195 mμ, respectively. The production of F centers is determined almost entirely by impurities with a small contribution due to intrinsic processes. The large coloration in hydroxide and peroxide doped samples are explained on the basis of photochemical reactions involving impurities which act as sources of anion vacancies and electrons. Important differences were observed in hydroxide and peroxide doped samples in relation to the charge state of the aggregate centers. Electron-deficient centers are stabilized and the probability of their formation is enhanced in hydroxide doped samples. In peroxide doped samples the excess electron centers are favored. Several new absorption bands were observed in hydroxide and peroxide doped samples. (USGRDR)

36964 (AD-665980) OPTICAL AND ELECTRON SPIN RESONANCE STUDIES OF THE ICl(-)V-K CENTER IN KCl:I. Goldberg, Lawrence S.; Meistrich, Marvin L. (Cornell Univ., Ithaca, N. Y. Materials Science Center). Feb. 29, 1968. Contracts Nonr-401(54); Nonr-401(47). 38p. (MSC-901). CFSTI.

The ICl (-)V-K center, a ⟨110⟩-oriented selftrapped hole center, was investigated in x-irradiated KCl : I and KCl : I : Pb at low temperatures by optical and electron spin resonance techniques. Three optical transitions are identified at 430, 840, and 1000 nm by anisotropic absorption measurements; their observed sigma polarizations and relative intensities are consistent with a molecular-orbital model modified for XY (-) molecule-ion centers. Pulse annealing experiments monitored by ESR and correlated with thermoluminescence data and absorption spectrum changes give information on the formation and thermal stability of ICl (-). An improved analysis of the ESR spectrum has been carried out taking into account deviations from axial symmetry. Calculations of the large iodine quadrupole interaction are extended to second-order perturbation theory, and observed forbidden transitions are fitted to these equations, allowing a determination of the sign, as well as the magnitude, of the quadrupole interaction. (USGRDR)

36965 (AD-666220) RADIATION EFFECTS IN SILICON AND GERMANIUM. Final Report. Curtis, O. L. Jr.; Bass, R. F.; Germano, C. A. (Northrop Corporate Labs., Hawthorne, Calif.). Nov. 1967. Contract DA-49-186-AMC-235(X). 161p. (NCL-67-63R; HDL-235-3). CFSTI.

The following were studied and are reported: (a) the influence of aluminum on carrier degradation in neutron-irradiated silicon; (b) dependence of carrier lifetime on excess density for neutron-irradiated silicon; (c) influence of impurities on carrier removal and annealing in neutron-irradiated silicon in the resistivity range from 0.5 to 50 ohm-cm; (d) recombination level position from the dependence of lifetime on excess density in n-type germanium following irradiation; (e) short-term annealing in bulk silicon following pulsed-neutron irradiation; and (f) carrier recombination at disordered regions in neutron-irradiated semiconductors. (auth) (USGRDR)

36966 (AERE-R-5729) X-RAY MICROSCOPY APPLIED TO MATERIALS SCIENCE, INCLUDING DIVERGENT BEAM ANALYSIS: BIBLIOGRAPHY. Baldock, P. J. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1968. 41p. Dep. CFSTI. UK 6s. 0d.

The bibliography is divided into sections by classification into the principal fields of development. Within the sections the references are given in chronological order, except that where one worker, or several workers from the same school, have written a series of papers these are kept together. In cases where an extensive single related technique has developed from, or with, the x-ray microscopy work, only the original papers are quoted. Biological and medical work are included if the apparatus or technique is important. An important development has been the combination of microscopy with diffraction techniques, and references are included when focussing of the electron or x-ray beam is involved. (auth) (UK)

36967 (COO-1054-39) ELECTRON PARAMAGNETIC RESONANCE STUDIES OF RADIATION INDUCED DEFECTS IN SINGLE CRYSTALS OF LITHIUM SULFATE. Aseltine, Clifford L. (Wayne State Univ., Detroit, Mich.). 1967. Contract AT(11-1)-1054. 119p. Dep. CFSTI.

Thesis.

Single crystals of $Li_2SO_4 \cdot H_2O$ were grown with labeled Li and H isotopes near room temperature and irradiated in 1-MeV electron beams near 77°K. EPR spectra measured without warming the sample were anisotropic with resolved proton (or deuteron) hyperfine structure. It is concluded that the defect of axial symmetry responsible for the spectra is probably an OH radical with insignificant bonding to its neighbor. When the same samples were warmed to room temperature and again returned to 77°K, the OH radical spectrum disappeared, and two new types (B and C) of spectra were observed. Type B was identified as a modification of the original OH radical. Type C was attributed to an oxygen radical of the form O_2^- formed simultaneously with the O_2H radical. Similar results were produced by gamma irradiation. Crystals irradiated by thermal neutrons produced types B and C spectra and also three new types of spectra. One of these new spectra was assigned to an O_3^- radical with increased ground-state splitting. The other two were attributed to SO_4^- radicals trapped in different environments. (A.G.W.)

36968 (COO-1054-40) OPTICAL STUDIES OF F-AGGREGATE COLOR CENTERS IN IRRADIATED LITHIUM FLUORIDE. Vander Lugt, Karel Leo (Wayne State Univ., Detroit, Mich.). 1967. Contract AT(11-1)-1054. 81p. Dep. CFSTI.

Thesis.

F centers and certain F-aggregate centers were produced in pure LiF by exposure to γ rays, x rays, or neutrons at room temperature. The crystals were subjected to selective bleaching techniques, and optical absorption, luminescence, and photoconductivity measurements were made. R_1 and R_2 bleach near 300°K revealed the existence of a new color center whose main absorption band covers the region of the R_1 and R_2 bands. The new center is not related to any of the known color centers, and facilitates the conversion of F_3^+ centers into R centers according to the mechanism $F_3^+ + e \rightarrow R$, where the electron is provided by the photoionization of the new color center by the R bleach. The destruction of R centers in LiF by R_1 and R_2 bleach was found to occur by two concurrent mechanisms: (a) decomposition of an R center into an M center and an F center, and (b) conversion of an R center into another color center whose absorption band (550 mμ) is in the N-band region. This mechanism is governed by first-order kinetics. These results favor a rearranged F_3 model for the N center over the current Pick model of an F_4 complex. (A.G.W.)

36969 (ITF-68-6) URAVNENIYA DVIZHENIYA DLYA PLOTNOSTI MAGNITNOGO MOMENTA FERRODIELEKTRIKA. RELAKSATSIYA YADERNYKH SPINOV FERROMAGNITNOI SISTEMY. (Motion Equations for Density of the Ferroelectric Magnetic Moment. Relaxation of Nuclear Spins of a Ferromagnetic System). Petrov, E. G. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 27p. (In Russian). Dep.

Using the nonequilibrium density matrix, the motion equations are obtained for the magnetization of the ferrodielectric as well as those for nuclear spins of impurity atoms of a ferromagnetic system. The relaxation time is calculated for the longitudinal and transverse components of the magnetization. It is shown that the relaxation time for nuclear spins and corrections to vibration frequencies are determined by the exact correlation functions describing fluctuations of the magnetic induction. (auth)

36970 (NIJS-P-212) OSNOVE MOESSBAUERJEVE SPEKTROSKOPIJE IN RAZISKAVE HIPERFINE STRUKTURE NIVOJA ENERGIJE 14,4 keV V NEKATERIH ZELEZNIH SPOJINAH. (On the Moessbauer Spectroscopy and the Study of the Hyperfine Structure of 14.4-keV Level in Some Iron Compounds). Hanzel, D. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Dec. 1967. 54p. (In Yugoslav). Dep.

Some theoretical foundations of recoilless transitions (such as transition matrix element, sum rule and Debye–Waller factor) as well as a review of experimental methods for measurements of Mössbauer effect are surveyed. Special attention is paid to the measurements of hyperfine structure of the velocity spectra. The spectra were measured by a velocity spectrometer having a sinusoidal wave drive. The device was calibrated by measuring the hyperfine spectrum of ^{57}Fe in metallic iron and Fe_2O_3. Measurements of the hyperfine spectra of the 14.4-keV γ rays from ^{57}Fe in the perovskite type compounds $BiFeO_3$ and $LaFeO_3$ were performed using powdered samples at different temperatures. From the velocity spectra hyperfine interactions of the ^{57}Fe nucleus in these materials were determined. Above the antiferromagnetic transition point of the $BiFeO_3$ only a quadrupole splitting in the spectra was observed. Below the Neel temperature the spectra for the $BiFeO_3$ absorber showed characteristics of a combined electric

and magnetic hyperfine coupling. With decreasing temperature a gradual increase of magnetic hyperfine coupling was observed. The internal magnetic field at the position of the Fe nucleus in $LaFeO_3$ is nearly the same as in Fe_2O_3. (auth)

36971 (RISO-178) INVESTIGATION OF MAGNONS IN RARE EARTH METALS BY INELASTIC NEUTRON SCATTERING. Moeller, H. Bjerrum (Danish Atomic Energy Commission, Risoe, Research Establishment). Mar. 1968. 70p. Dep.

A description is given of an experimental investigation of the magnetic interactions in Tb and Tb-10% Ho by the technique of inelastic neutron scattering. The experimental method is described with special regard to those features of the technique that allow an accurate determination of the energies and lifetimes of the magnons. The interpretation of the data is discussed, with reference to the relation between the conduction electron band structure and the indirect exchange interaction between the magnetic ions. The interactions of magnons with each other and with phonons, electrons, and impurities are also considered. (Denmark)

36972 (UCRL-Trans-10245) DIELECTRIC DISPERSION IN NEUTRON-IRRADIATED LITHIUM-FLUORIDE CRYSTALS. Curien, Hubert; Fructus-Ricquebourg, Jeannine. Translated by I. M. R. Jones for Univ. of California Lawrence Radiation Lab., Livermore, from Compt. Rend., 253: 850-2(1961). 6p. Dep. CFSTI.

In the frequency range from 50 to 100,000 Hz a double dielectric dispersion can be demonstrated on monocrystalline LiF strips irradiated with neutrons. Heat treatment permits development of one of the relaxation regions to the advantage of the other. (auth)

36973 (UCRL-Trans-10246) NEW EVIDENCE OF METALLIC-LITHIUM PRECIPITATION IN LITHIUM SALTS IRRADIATED WITH THERMAL NEUTRONS. Lambert, Marianne; Berge, Pierre; Mazieres, Charles; Guinier, Andre. Translated by I. M. R. Jones for Univ. of California Lawrence Radiation Lab., Livermore, from Compt. Rend., 249: 2054-6(1959). 6p. Dep. CFSTI.

Differential thermal microanalysis confirms the results obtained previously by x-ray diffraction in the case of LiF. These two methods and chemical assay were used to study the decomposition of LiH by neutrons. Evidence for precipitation of metallic Li was found in every case. (auth)

36974 (UCRL-Trans-10247) STRUCTURAL DEFECTS IN NEUTRON-IRRADIATED LITHIUM FLUORIDE. SUBMICROSCOPIC CAVITIES. Lambert, Marianne; Guinier, Andre. Translated by I. M. R. Jones for Univ. of California Lawrence Radiation Lab., Livermore, from Compt. Rend., 244: 2791-4(1957). 8p. Dep. CFSTI.

The dimensions and concentration of cavities, detected by x-ray scattering, in neutron-irradiated LiF are determined as a function of the irradiation rate and recovery heat treatment. (auth)

36975 (UCRL-Trans-10248) EFFECT OF IMPURITIES ON THE OPTICAL PROPERTIES OF IRRADIATED LITHIUM FLUORIDE. Dubois, M.; Berge, P.; Benveniste, M.; Blanc, G. Translated by I. M. R. Jones for Univ. of California, Lawrence Radiation Lab., Livermore, from J. Phys. (Paris), 25: 1017-23(1964). 17p. Dep. CFSTI.

An abstract of the original paper appeared previously in NSA as 19: 19998. (A.G.W.)

36976 EFFECT OF PRESSURE ON THE ISOMER SHIFT OF ^{57}Fe IN THE bcc PHASE. Moyzis, J. A. Jr.; Drickamer, H. G. (Univ. of Illinois, Urbana). Phys. Rev., 171: 389-92(July 10, 1968).

The effect of pressure to 130 kbar has been measured on the isomer shift of bcc iron, using the inner two lines of the magnetically split six-line iron spectrum. The isomer shift is nearly linear in pressure to about 60 kbar; at higher pressures the rate of shift to higher electron density is less. The data are not linear with volume in the higher-pressure region either. The results are interpreted in terms of Ingall's discussion of the transfer of electrons from the 4s to the 3d bands and the value of the proportionality constant between the isomer shift and the square of the wave function. The change in magnetic field with pressure is discussed very briefly. (auth)

36977 ISOMER SHIFT AND HYPERFINE SPLITTINGS OF THE 59.6-keV MOESSBAUER RESONANCE IN ^{237}Np. Dunlap, B. D.; Kalvius, G. M.; Ruby, S. L.; Brodsky, M. B.; Cohen, D. (Argonne National Lab., Ill.). Phys. Rev., 171: 316-21(July 10, 1968).

The Mössbauer resonance of the 59.6-keV transition in ^{237}Np was observed in a variety of chemical compounds, using the α decay of ^{241}Am as a source. The shift of the resonance as a function of the charge state of neptunium, coupled with atomic self-consistent-field calculations for the electron densities at the nucleus, leads to a change in the nuclear charge radius $\Delta\langle r^2\rangle/\langle r^2\rangle = -3.5 \times 10^{-4}$. Using the collective nuclear model, this number can be expressed as a change in the nuclear deformation of $\Delta\beta/\beta_0 = -6.3 \times 10^{-3}$. All compounds investigated exhibited electric quadrupole or magnetic hyperfine splitting, or both. These data confirmed the earlier results of the ratios of the nuclear moments as $g^*/g = 0.533 \pm 0.005$ and $Q^*/Q = 1.0 \pm 0.1$. (auth)

36978 HYPERFINE STRUCTURE OF ^{197}Au IN Fe MEASURED WITH THE MOESSBAUER EFFECT. Cohen, R. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 171: 343-4(July 10, 1968).

The Moessbauer effect was used to study the hfs of ^{197}Au in Fe. The moment of the 77.3-keV first excited state was found to be $+0.419\ \mu_N$ and the internal field to be 1.28 MOe. These values are somewhat different from, and more accurate than, previous results. (auth)

36979 MOESSBAUER-EFFECT MEASUREMENTS IN IRON AT HIGH PRESSURES. Southwell, W. H.; Decker, D. L.; Vanfleet, H. B. (Brigham Young Univ., Provo, Utah). Phys. Rev., 171: 354-60(July 10, 1968).

Six-line Moessbauer spectra were obtained for ^{57}Fe in a natural iron-foil source over the pressure range 0 to 85 kbar, using a tetrahedral anvil press. An analysis of the data yielded the following results: The linewidth was not altered by pressure and was consistent with the ^{57}Fe thickness of the source and absorber. The relative line intensities changed from 2.8 : 2.4 : 1.0 : 1.0 : 2.4 : 2.8 at atmospheric pressure to 2.6 : 1.3 : 1.0 : 1.0 : 1.3 : 2.6 at 80 kbar. This indicates that pressure polarized the iron foil so that the magnetic moments rotated out of the plane of the foil. This polarization was reversible. The isomer shift decreases linearly with pressure with a slope $(-7.46 \pm 0.21) \times 10^{-5}$ cm sec^{-1} kbar^{-1}. The effective magnetic field at the nucleus also decreased with pressure according to $\Delta H/H_0 = (-1.34 \pm 0.25) \times 10^{-4} P - (0.60 \pm 0.39) \times 10^{-6} P^2$, with P in kbar. A small quadrupole splitting was observed with the source under pressure, which increased as $\partial E_Q/\partial P = (0.96 \pm 0.23) \times 10^{-5}$ cm sec^{-1} kbar^{-1}. The ratio of the splitting of the excited to the ground state was measured as $g_1/g_0 = 0.5714 \pm 0.0011$ and was independent of pressure. The absorption areas of the Moessbauer lines were measured, but attempts to calculate the *f* factor indicate a possible variation of *f* with polarization. Possible explanations are given for the polarization effect and quadrupole splitting. (auth)

36980 MOESSBAUER FARADAY EFFECT. Housley, R. M.; Gonser, U. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Rev., 171: 480-4(July 10, 1968).

The dispersion associated with Moessbauer resonance absorption has been analyzed. Special attention is given to the problem of the rotation of linearly polarized recoil-free 14.4-keV γ rays transmitted through a resonantly absorbing material (transmitter) with longitudinal applied field (nuclear Faraday effect). A simple zero-velocity Moessbauer polarimeter and its operation are described. It has been used to measure the Faraday effect in the ferrimagnetic spinel $MgFe_2O_4$. (auth)

36981 RESONANT ABSORPTION IN THE PRESENCE OF FARADAY ROTATION. Blume, M.; Kistner, O. C. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 171: 417-25 (July 10, 1968). (BNL-12217).

A general treatment of electro- and magneto-optical phenomena in the presence of resonant absorption is given. The resulting expressions in terms of the real and imaginary parts of a matrix index of refraction are easily utilized in calculations. The effects of these phenomena in Moessbauer experiments with polarized γ rays are considered in detail; expressions for absorption as a function of polarization as well as for the polarization of the transmitted beam, which are valid for arbitrarily thick absorbers, are presented. Comparisons with experimental data are presented. (auth)

36982 TIME DEPENDENCE OF MOESSBAUER SCATTERED RADIATION. Thieberger, P.; Moragues, J. A.; Sunyar, A. W. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 171: 425-35(July 10, 1968).

Time distributions of resonantly scattered 14.4-keV ^{57}Fe γ rays were measured by using as time-zero signals the preceding 122-keV γ rays. A ^{57}Co source coplated with Fe was used with two different metallic scatterers (2.54×10^{-2}-mm-thick 92.8% ^{57}Fe and 4.53×10^{-2}-mm-thick 2.19% ^{57}Fe) in a cylindrical geometry. Measurements were performed at different relative source velocities. From the measured time spectra, contributions due to random coincidences and to Rayleigh scattering were subtracted. A theory based on a classical model in which the scattering nuclei are represented by randomly situated harmonic oscillators was developed. The experimental results are compared with computed theoretical

curves. Good agreement was found in most of the cases. Discrepancies observed in two instances are discussed. (auth)

36983 NUCLEAR MAGNETIC RESONANCE IN DILUTE ALLOYS OF INDIUM–LEAD AND INDIUM–TIN. Anderson, W. T. Jr.; Thatcher, F. C.; Hewitt, R. R. (Univ. of California, Riverside). Phys. Rev., 171: 541-8(July 10, 1968).

Measurements have been made at 4.2°K of the isotropic Knight shift, the anisotropic Knight shift, and the electric quadrupole coupling of ^{115}In as a function of the solute concentration to 5.8 at. % of Pb in In–Pb and to 9.7 at. % of Sn in In–Sn. The ^{119}Sn isotropic Knight shift was also measured in the range 2.9 to 9.7 at. % Sn in the In–Sn alloys. A comparison of these results with the scattering theories of Blandin and Daniel and of Kohn and Vosko is made. Qualitative agreement is found in the isotropic Knight shift from 2 to 6 at. % for both alloy systems. Both systems show a sharp dip in the Knight shift in the 0 to 2 at. % range that are not attributable to the scattering mechanism. The electric-field-gradient calculations show that the ionic and conduction-electron gradients are both negative. A qualitative test in this model for the Sternheimer antishielding factor is in agreement with the value $1 - \gamma_\infty = 25.9$. (auth)

36984 MAGNETOELASTIC BEHAVIOR OF EUROPIUM OXIDE. II. MAGNETOSTRICTION AND THE λ ANOMALY. Argyle, B. E.; Miyata, N. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., 171: 555-62(July 10, 1968).

Magnetostriction of single-crystal EuO was determined in the temperature range 4.2 to 150°K in applied magnetic fields up to 20 kOe. Linear magnetostriction coefficients extrapolated to 0°K are $\lambda_{100} = -22 \times 10^{-6}$ and $\lambda_{111} = 55 \times 10^{-6}$. These yield the magnetoelastic coupling constants $b_1(0) \equiv -\frac{3}{2}\lambda_{100}(c_{11} - c_{12}) = (31 \pm 6) \times 10^6$ and $b_2(0) \equiv -3\lambda_{111}c_{44} = -(86 \pm 10) \times 10^6$ dyn/cm^2. Their decrease with increasing temperature appears to be explained by a 1:1 admixture of longitudinal single-ion and two-ion spin correlation as described by $\lambda(T) = \lambda(0)[\bar{l}_3(L^{-1}(m))]$ and $\lambda(T) = \lambda(0)m^2$, respectively. This suggests that the magnetoelastic Hamiltonian contains one-ion (B_1, B_2) and two-ion (D_1, D_2) magnetoelastic constants, $B_1 \approx D_1 \approx \frac{1}{2}b_1$ and $B_2 \approx D_2 \approx \frac{1}{2}b_2$. Since classical dipole–dipole interactions in EuO theoretically give $D_1^{cl} = -6.4 \times 10^6$ and $D_2^{cl} \approx +4.3 \times 10^6$, it is estimated for pseudodipolar effects $D_1^p \approx 21 \times 10^6$ and $D_2^p = -47 \times 10^6$ dyn/cm^2. The forced (volume) magnetostriction λ_f was obtained versus applied magnetic field and is plotted versus the internal magnetic field. These results, which reflect the behavior of short-range order (isotropic spin–spin correlations) in the presence of a magnetic field, are qualitatively similar to predictions of the two-particle cluster calculation by E. R. Callen and H. B. Callen. The Landau–Belov phenomenological theory, which is often used to estimate the pressure derivative of the transition temperature from data of λ_f versus σ^2, leads to results inconsistent with other determinations for dT_c/dP in EuO and with the theoretical and experimental results in a previous paper, showing that EuO exhibits a temperature-independent magnetic Grüneisen parameter. Data exhibiting suppression of the λ anomaly in thermal expansivity by applied magnetic fields are also presented. The peak is rounded and its magnitude reduced by a factor of $\approx\frac{1}{2}$ at 18 kOe. (auth)

36985 FERROMAGNETISM OF $CrBe_{12}$. Wolcott, N. M.; Falge, R. L. Jr. (National Bureau of Standards, Washington, D. C.) Phys. Rev., 171: 591-5(July 10, 1968).

The intermetallic compound $CrBe_{12}$ has been found to be ferromagnetic at low temperatures. The ferromagnetic and paramagnetic Curie temperatures are each about 50°K, and at 1.4°K the saturation moment is approximately 0.2 Bohr magnetons per chromium atom. In the liquid-nitrogen temperature range, the magnetization follows a Curie–Weiss law with an effective magneton number of 2.22 Bohr magnetons per chromium atom. The experimental results are discussed in relation to possible magnetization schemes, and compared with other ferromagnetic intermetallic compounds. The compounds Nb_2Be_{17}, $NbBe_{12}$, Ta_2Be_{17}, $TaBe_{12}$, $MnBe_{12}$, UBe_{13}, $MoBe_{12}$, $ZrBe_{13}$, and $CaBe_{13}$ were found to be nonmagnetic and nonsuperconducting above 1.4°K. (auth)

36986 RADIATION EFFECTS IN SEMICONDUCTORS. Proceedings of the Santa Fe Conference on Radiation Effects in Semiconductors, October 3–5, 1967. Vook, Frederick L. (ed.). New York, Plenum Press, 1968. 496p. (CONF-671058).

Separate abstracts were prepared for 36 of the 46 papers presented. The remaining papers include an introduction to the conference and discussions of general theory of defects. (A.G.W.)

For abstracts of individual papers see: 36987–37022.

36987 PHOTOCONDUCTIVITY SPECTRA OF LOW-TEMPERATURE ELECTRON-IRRADIATED GERMANIUM. Fischer, J. E.; Zizine, J. L.; Cherki, M. (Ecole Normale Superieure, Paris). pp 219-23 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Photoconductivity measurements have been performed on n-type Ge following 4°K and 20°K bombardments with ≤2-MeV electrons and 90°K heat treatment. For the purer sample, a quenching spectrum is observed following 4°K irradiation; the major feature is a level near 6 μ, which recovers completely below 90°K. In the case of heavier doping, the post-irradiation spectrum is "normal" and exhibits weak structure in the range 1.5 to 6 μ, which is not strongly affected by the 90°K anneal. (auth)

36988 FAST RECOVERY OF ELECTRON-IRRADIATED GERMANIUM. Bourgoin, J.; Baruch, P. (Ecole Normale Superieure, Paris). pp 210-18 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

The fast recovery of electron concentration after a burst of 1-MeV electrons (1 mA during 15 μsec) was studied near 100°K in high-purity n-type Ge (10^{13} to 3×10^{13} Sb/cm^3). Three different stages were observed: (1) a fast decrease (10 μsec) of excess carrier concentration; (2) a further decrease below the initial concentration during 6 msec; and (3) a return toward the initial concentration through defect annealing. Stage (2) can be attributed to filling of traps either created by irradiation or grown in the crystal. The time constant for stage (3) at 100°K is 24 msec, and the activation energy near 100°K is 0.14 eV. This stage appears negligible below 60°K as expected if it corresponds to the 65°K defect. This behavior can be interpreted by a model based on the creation of a transient defect, stabilized by electronic capture and then decaying by the usual annealing process. (auth)

36989 PHOTO-INDUCED ANNEALING IN n-TYPE GERMANIUM. Arimura, Itsu; MacKay, J. W. (Purdue Univ., Lafayette, Ind.). pp 204-9 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

The effects of infrared illumination on the conductivity and annealing properties of low-temperature irradiated n-type germanium are studied. Irradiations were performed at liquid-helium temperature on single-crystal germanium specimens containing about 2×10^{14} Sb atoms per cm^3. Photoinduced annealing is observed over the entire temperature range from 4.5 to 60°K depending upon the illumination. A comparable specimen annealed in the dark displays only a large recovery stage at 65°K. This stage was shifted to about 25°K in the presence of illumination that created free holes. The photoconductivity associated with these annealable defects reveals that they are most likely double-acceptor defects. (auth)

36990 IRRADIATION-TEMPERATURE DEPENDENCE OF DEFECT PRODUCTION IN GERMANIUM. Whan, R. E. (Sandia Lab., Albuquerque, N. Mex.). pp 195-203 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Infrared-absorption investigations of the production of oxygen-defect complexes in germanium at carefully controlled irradiation temperatures between 50 and 140°K are reported. The intensities of two prominent bands associated with these complexes are found to increase linearly with incident 2-MeV electron fluence, Φ. The exponential dependence of the production rates of the bands as a function of the irradiation temperature, T, can be expressed by the equation $d\alpha/d\Phi = A \exp(-\Delta E/kT)$ where ΔE is 0.01 eV for both bands, α is the absorption coefficient, and A is a constant. The temperature dependence of the production of the complex is attributed to the temperature dependence of the production of interstitials and vacancies. This effect is interpreted in terms of a metastable vacancy–interstitial pair model of defect production. (auth)

36991 LOW-TEMPERATURE IRRADIATION AND ANNEALING OF n-TYPE GERMANIUM: EFFECTS OF OPTICAL BLEACHING. Zizine, J. (Ecole Normale Superieure, Paris). pp 186-94 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

This study at 65°K of the annealing kinetics of 1.5-MeV electron-irradiated n-type germanium shows that the reaction that takes place at this temperature is a diffusion-controlled recombination of correlated pairs. It shows that the 65°K annealing stage is an annihilation of close vacancy–interstitial pairs by diffusion. This reaction is very sensitive to the electronic excitation due to white

light. The comparison between an isochronal annealing in the dark and an isochronal annealing under light gives a surprising result. The stage that appears usually around room temperature disappears when the low-temperature annealing is performed under white light. (auth)

36992 EFFECTS OF DEFECT CHARGE STATE ON RADIATION DAMAGE IN SEMICONDUCTORS. MacKay, J. W.; Klontz, E. E. (Purdue Univ., Lafayette, Ind.). pp 175-85 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

The present state of knowledge concerning the equilibrium charge states of "isolated" vacancies and interstitials is reviewed. It is pointed out that the charge states will not be the same during electron irradiation as in equilibrium. The annealing process in n-type Ge that occurs at 65°K after irradiation at 10 to 20°K is discussed. This stage is clearly charge-state dependent and can be made to proceed at lower temperatures by illumination of a damaged specimen. Annealing occurs, even at 4.2°K, when photons with energy less than the band gap are incident on a specimen. It is pointed out that this behavior is not consistent with a close-pair metastable defect model. Also, results of Zizine indicate that impurities are involved in the annealing at 65°K. If this is so, the close-pair model must be abandoned. An alternative to the metastable pair model is proposed. This new model is based on the idea of a very mobile interstitial atom trapped, at low temperature, by Group-V impurities. Some possible effects of a very mobile interstitial atom on irradiation damage behavior in Ge and Si are discussed. (auth)

36993 EFFECT OF IMPURITIES ON RADIATION DEFECTS OF p-TYPE SILICON. Nakashima, K.; Inuishi, Y. (Osaka Univ.). pp 162-71 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Research on the effect of impurities such as oxygen, Ni, Cu, and various dopants on radiation damage in p-type Si is reported. From the temperature dependence of lifetime and carrier concentration, the nature of the negative annealing at 200 to 250°C in gamma-irradiated pulled Si is ascribed to the appearance of deep-lying centers having large recombination cross sections. It was found that the annealing atmosphere produces a large effect on the annealing behavior of lifetime in gamma-irradiated Si. Annealing in water vapor and in silicone oil containing Cu produces remarkable negative annealing even in floating-zone Si. In the case of neutron irradiation, these effects were found to be small. (auth)

36994 RADIATION-INDUCED PHOTOCONDUCTIVITY OF SILICON. Kalma, A. H.; Corelli, J. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). pp 153-61 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

The photoconductivity induced in zone-refined silicon doped with As, P, and Sb to resistivities in the range of 1 to 100 Ω-cm was studied after bombardment with 1.5-MeV and 45- to 50-MeV electrons. The dominant defect photoconductivity in all samples irradiated at 45 to 50 MeV is found to arise from an "energy band" extending from ≈1.5 to ≈4.0 μ. A possible explanation of this energy band is given. Single well-defined defect energy levels dominate the photoconductivity of 1.5-MeV irradiated samples. Using stress-induced atomic and electronic reorientation together with annealing studies and correlating the results with previous electron paramagnetic resonance and infrared absorption experiments, levels located at $E_c - 0.54$ eV and $E_c - 0.39$ eV are identified as arising from the divacancy defect. (auth)

36995 EFFECTS OF UNIAXIAL STRESS ON THE PHOTOCONDUCTIVITY SPECTRA IN NEUTRON-IRRADIATED p-TYPE Si. Cheng, L. J. (Chalk River Nuclear Labs., Ont.). pp 143-52 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

The photoconductivity spectra in neutron-irradiated Si have been studied by a technique employing uniaxial stress and polarized light. It has thus been possible to correlate the 3.9-μ photoconductivity band with the singly positively charged divacancy. The photo-excited carrier causing the 3.9-μ photoconductivity band is not created by a direct excitation from the defect level to the valence band, but by a local excitation followed by the emission of a hole from the empty ground state of the excited defect. The results may also indicate that the valence band in the space occupied by the singly positively charged divacancy is badly distorted to become one or several discrete levels. In addition, it has been found that the electronic distribution of the defect causing the level at $E_v + 0.42$ eV has a ⟨111⟩ symmetry. (auth)

36996 RADIATION ANNEALING IN DEGENERATE n-TYPE SILICON. Klontz, E. E.; Sivo, L. L. (Purdue Univ., Lafayette, Ind.). pp 136-42 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Damage produced by 1.0-MeV electrons in degenerate n-type silicon at temperatures above 70°K can be annealed by continuing the irradiation at lower temperatures. Both pulled and floating-zone crystals exhibit this effect. Induced annealing is considerably reduced at temperatures above that at which the vacancy becomes mobile while the rate of damage introduced rises nearly exponentially. Results are accounted for by a model suggested by MacKay, based on the release of highly mobile interstitial atoms from shallow traps to annihilate vacancies associated with impurities in the crystal. (auth)

36997 DEFECT REORDERING AT LOW TEMPERATURES IN GAMMA-IRRADIATED n-TYPE SILICON. Gregory, B. L.; Barnes, C. E. (Sandia Lab., Albuquerque, N. Mex.). pp 124-35 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

During low-temperature gamma irradiation of n-type silicon the defects introduced are of two general types: (1) a type characterized by an irradiation-temperature-independent (ITI) introduction rate, and (2) a type whose introduction rate is irradiation-temperature-dependent (ITD). Minority carrier lifetime studies have been performed on Co-60 gamma-irradiated p/n silicon solar cells to determine the effects on the ITI and ITD defects of varying (a) the material resistivity, (b) the minority carrier injection level, and (c) the irradiation temperature. The results indicate that the introduction rate of both types of defects depends strongly on injection level. The observed dependences of the ITI defect introduction rate on injection level, resistivity, and measurement temperature have been explained by a three-charge-state model for the defect. A metastable close-pair model is employed to explain the irradiation-temperature and resistivity dependence of the ITD introduction rate. In this model the ITD defects possess an energy level at approximately $E_c - 0.07$ eV. The potential barriers to recombination and dissociation depend on the electronic occupancy of this level. (auth)

36998 CHARACTERISTICS OF ELECTRON-INDUCED DEFECTS IN n-TYPE SILICON. Stein, H. J.; Vook, F. L. (Sandia Lab., Albuquerque, N. Mex.). pp 115-23 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Defects induced in n-type silicon by electron irradiation at temperatures between 75 and 100°K are primarily of two kinds, which have different mechanisms of production. The production of one kind of defect is irradiation-temperature-independent (ITI), and the production of the other kind is irradiation-temperature-dependent (ITD). Production of ITD defects is interpreted to depend upon the product of the formation rate of metastable vacancy–interstitial pairs and the temperature-dependent probability for vacancy and interstitial separation. Once separated, the free vacancies and interstitials interact with impurities in the crystal to give the crystal-growth-dependent ITD defects. The electron-energy dependence of the carrier removal by ITD defects at low temperature closely parallels the previously measured energy dependence for carrier removal at room temperature for electron energies <1 MeV. This agreement suggests that the energy dependence measured at room temperature should be interpreted as that for producing the metastable pair. Production of the ITI defects is independent of the dominant crystal impurities and thermal annealing occurs between 100 and 200°K with an activation energy of 0.4 eV for an unannealed fraction of 0.5. The electron-energy dependence for production, the magnitude of the production rates, and the annealing temperature for ITI defects are very similar to those for the non-reorientable divacancy previously observed in EPR measurements. (auth)

36999 PRODUCTION OF DEFECTS IN n-TYPE SILICON. Vook, F. L.; Stein, H. J. (Sandia Lab., Albuquerque, N. Mex.). pp 99-114 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Optical absorption and electrical measurements in low-temperature-irradiated n-type silicon are reviewed to determine the mechanisms of defect production and the inventory of elec-

trically active defects. These measurements show that one kind of defect production in n-type silicon decreases exponentially with increasing reciprocal irradiation temperature at temperatures between 75 and 100°K for electron energies between 0.25 and 2 MeV. Vacancy–impurity complexes are the major defects of this kind, but there is also evidence that interstitial–impurity complexes are formed. Electrical measurements show that the production of such defects is dependent on the electrical resistivity and on charge carrier injection during irradiation. A generalized model incorporating models of MacKay and Klontz and of Wertheim, involving the production of metastable interstitial–vacancy pairs, is used to interpret the results. It is proposed that the metastable pair exists in two charge states differing by one electronic charge, and has an energy level ~0.07 eV below the conduction band. The barrier to recombination of the pair is assumed to be lowered in the more negative charge state. The rate-limiting step in the production of defects via the breakup of the pair is taken to be proportional to the probability that the metastable pair is ionized and is in the more positive charge state. Electrical measurements also show that a second kind of defect is produced at a rate that is irradiation-temperature-independent (ITI), and that it anneals between 100 and 200°K. These defects are produced by electron, Co-60 gamma-ray, and apparently also by neutron irradiation. The relative importance of the ITI defect production increases with increasing electron energy. Correlations of the annealing stages observed in the carrier removal and mobility measurements with specific defects permit a defective inventory based upon carrier removal rate. These results indicate that, together with the ITI defects, the major identified defects are also the dominant electrically active defects. (auth)

37000 ESR STUDIES OF ELECTRON IRRADIATION DAMAGE AND ITS ANNEALING IN As-DOPED n-TYPE GERMANIUM. Hasiguti, R. R. (Tokyo Univ.); Tanaka, K.; Takahashi, S. pp 89-96 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

New ESR spectra were observed in As-doped n-type germanium crystals irradiated by 6-MeV electrons at 40°C. Various characteristics, including the annealing behavior of the spectra, were investigated in detail. One of the spectra, called the C spectrum, was analyzed and interpreted to be due to an arsenic–divacancy complex. The annealing behavior of the irradiated crystal is explained in terms of the behavior of the arsenic–divacancy complex. (auth)

37001 EPR AND OPTICAL ABSORPTION STUDIES IN IRRADIATED SEMICONDUCTORS. Watkins, G. D. (General Electric Research and Development Center, Schenectady, N. Y.). pp 67-81 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

EPR results in irradiated silicon are reviewed. The importance of the Jahn–Teller effect in determining the electronic structure and level position in the forbidden gap for all defects involving vacancies is emphasized. Also, new data are presented for irradiations at ~100°K in p-type silicon, which point to complex temperature-dependent damage mechanisms that are not understood. Optical absorption studies in silicon are also reviewed. These include the localized vibrational mode spectra of defects involving oxygen as well as electronic excitation of defects. New bands at ~1.7 to 1.8 μ are presented, which are identified as electronic excitations of the Group V atom–vacancy pairs. (auth)

37002 SURVEY OF CHANNELING THEORIES. Brice, D. K. (Sandia Lab., Albuquerque, N. Mex.). pp 386-97 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Contributions to both the classical and dynamical diffraction theories of channeling are surveyed briefly. These theories are primarily concerned with describing the process by which a particle is guided or channeled through a crystal lattice. Calculation of interaction rates under channeling conditions for processes that do not directly contribute to the guiding properties of the crystal is also discussed. Although there has been some question in the past as to whether diffraction effects were important for proton channeling, recent calculations indicate that classical methods are adequate to describe the guiding process for charged particles heavier than a few electron masses. Diffraction effects are important, however, in describing electron, positron, and neutron channeling. (auth)

37003 SURVEY OF EXPERIMENTAL CHANNELING RESULTS. Brown, W. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 359-85 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

The trajectories of energetic charged particles in crystalline solids are strongly affected in low-index crystal directions by correlated collisions of the particles with the ordered array of atoms of the lattice. Particles in such "channeling" trajectories are subject to lower-than-normal energy loss and multiple scattering and have lower-than-normal nuclear reaction yields. The channeling phenomena are sensitive to lattice perfection and thus can provide information on structural defects such as those produced in radiation damage. Because channeling particles avoid large-momentum-transfer collisions with atoms, the extent of damage produced in aligned trajectories is reduced below normal; however, few experiments of this kind have been made. The types of channeling experiments that have been done are surveyed and the observed or potential relation of these to the field of radiation damage is indicated. (auth)

37004 X-RAY-DIFFRACTION IMAGE TOPOGRAPHY AND OPTICAL INTERFERENCE PATTERN IN DIAMOND LAYERS AFTER ION BOMBARDMENT. Vavilov, V. S.; Galkin, V. V.; Gusseva, M. I.; Ershova, L. M.; Kisseleva, K. V.; Krasnopevtsev, V. V.; Milutin, Yu. V. (Lebedev Inst. of Physics, Moscow). pp 346-56 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

As a result of the bombardment of diamond by 40-keV lithium ions to a fluence of 10^{16} cm^{-2}, a layer of highly damaged lattice is formed. The damaged part of the crystal consists of two layers (the thickness of both less than 1 μ) characterized by different degrees of damage, refractive indices, and extinction indices. The thin "sandwich" of layers induces in the adjoining crystal volume elastic strain to a depth of about 200 μ. Annealing between 400 and 700°C results in the graphitization of the second, deeper, more-damaged layer. After high-temperature prolonged annealing at 1050°C, the graphitization process includes also the first, less damaged layer. Strong etching removes the graphite from the bombarded diamond, after which the crystal becomes transparent and strain-free. (auth)

37005 OBSERVATION OF CRYSTAL LATTICE PLANES IN ION-BOMBARDED GERMANIUM. Parsons, J. R.; Hoelke, C. W. (Chalk River Nuclear Labs., Ont.). pp 339-45 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Transmission-electron-microscopy techniques have been used to observe the crystal lattice spacing of (111) planes in 100-keV oxygen-ion-bombarded germanium. The perturbation, caused by the damaged region, to the regular spacing of these crystal lattice planes has been examined to determine the magnitude and extent of their associated strain fields. Pronounced interplanar spacing variations extending out to less than one-half the damaged region radius were readily detected by visual examination. Outside this region, the presence of (111) plane spacing variations in excess of 0.004 Å has been detected by laser-beam diffraction experiments. These variations extended out to more than 500 Å from the damaged-region center. (auth)

37006 CARRIER RECOMBINATION IN IRRADIATED n-TYPE GERMANIUM. Curtis, O. L. Jr.; Germano, C. A. (Northrop Corporate Labs., Hawthorne, Calif.). pp 331-38 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

The recombination level positions in arsenic- and antimony-doped germanium have been determined by observing the dependence of lifetime on excess density following neutron and Co-60 gamma irradiation. Two levels, one deep and the other comparatively shallow, are required to explain the data. The deep level, dominant at low excess densities, was the main object of this investigation. Neglecting statistical weight, the position of this level in As- and Sb-doped gamma-irradiated material is 0.331 and 0.338 eV, respectively. A similar impurity dependence occurs in neutron-irradiated material; also, an apparent dependence on resistivity occurs, which can be explained on the basis of disordered regions. Comparison of the dependence of lifetime on excess density and temperature indicates a strongly temperature-dependent electron-capture probability, especially in neutron-irradiated material. (auth)

37007 EXPERIMENTAL OBSERVATION OF DAMAGE CLUSTERS IN SEMICONDUCTORS. Bertolotti, M. (Univ., Rome). pp 311-30 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

The experimental information supporting the presence of clusters of defects in various semiconductors is reviewed. The results obtained with a direct method are also presented and discussed. The method allows observation of damage regions created by neutron and ion irradiation by etching the semiconductor surface with a chemical etch and making a replica that is observed in an electron microscope. (auth)

37008 RADIATION-INDUCED DEFECTS IN SEMICONDUCTORS: A MEASUREMENT TECHNIQUE AND APPLICATIONS TO γ-IRRADIATED SILICON. Landis, D. (Stanford Univ., Calif. Lockheed Missiles and Space Co., Palo Alto, Calif.); Pearson, G. L. pp 301-7 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

A technique is developed that determines with high precision the energy levels and introduction rates of radiation-induced defects in semiconductors. The technique uses constant-temperature measurements of carrier concentration versus radiation fluence. Applications to irradiations of oxygen-containing silicon by ^{60}Co are given. (auth)

37009 THEORETICAL TECHNIQUE TO DETERMINE ANISOTROPY OF RADIATION DAMAGE RATE IN SILICON. Hemment, P. L. F.; Stevens, P. R. C. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). pp 290-300 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Computer programs have been developed to predict the damage rates to be expected in silicon from electron irradiations at near-threshold energies and for various specimen orientations and thicknesses. The McKinley–Feshbach treatment of the relativistic Rutherford-scattering cross section is used to generate a primary recoil spectrum of silicon atoms in terms of both energy and angle of the recoil. Correction is made for both the angular spread and the energy degradation of the electron beam as it penetrates deeper into the specimen. By comparing the recoil spectrum with an assumed anisotropic displacement energy, it is possible to sum over the appropriate parts of the spectrum to arrive at the total displacement rate. By fitting the calculated curves of displacement rate versus electron beam energy and also versus specimen orientation to experimental results, it was possible to make suggestions concerning the anisotropy of the displacement energy. (auth)

37010 ENERGY AND ORIENTATION DEPENDENCE OF DEFECT PRODUCTION IN SEMICONDUCTORS. Banbury, P. C. (Univ. of Reading, Eng.). pp 280-9 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Some aspects of the energy and orientation dependence of the displacement rate in semiconductors of diamond and zinc-blende structure subject to electron irradiation are briefly surveyed. Experimental problems are discussed, and some recent results are reviewed. Their interpretation in terms of anisotropy of the displacement energy and its relation to the bonding configuration in these structures is discussed. Some results of computations now in progress are reported. (auth)

37011 DISPLACEMENT CROSS SECTIONS BY FAST ELECTRONS. Oen, O. S. (Oak Ridge National Lab., Tenn.). pp 264-79 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Some of the details and assumptions involved in the calculation of defect production by the recoil mechanism are reviewed. It is concluded that the Yang formula, which gives the average increase in path length through a sample, should be accurate provided one uses a mean square scattering angle of an appropriate multiple scattering theory. For electrons having energies customarily used in radiation damage the multiple scattering theory of Molière is much better than that of Rossi and Greisen. (auth)

37012 PARTITION OF ENERGY OF SILICON AND GERMANIUM RECOILS AND APPLICATION TO NEUTRON-INDUCED EFFECTS. Sattler, A. R. (Sandia Lab., Albuquerque, N. Mex.). pp 243-63 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

The energy partition of energetic Si and Ge atoms in their own lattices is reviewed. The discussion begins with the Lindhard theory, which predicts the amount of energy going into electronic processes and the amount of energy going into atomic processes. This theory provides a framework for discussion of experimental results. The ionization experiments from which the energy partition is obtained are outlined, beginning with the early experiments in which pulse height defects were noted and concluding with experiments designed to measure the ionization produced by an energetic Si(Ge) atom in a Si(Ge) lattice over a wide range of primary energies. The pulse height of an energetic atom in its host lattice relative to an electron of the same energy is the basis for all the ionization experiments, and is shown to give a good approximation to the fraction of the energy that goes into electronic processes; the remainder goes into atomic processes. The energy partition of all energetic ions in Si and Ge is presented and compared with a modified theory expressed in terms of the works of Bohr and Lindhard. Application of this energy partition to the case of neutron irradiation is then reviewed beginning with the early attempts to describe neutron damage in Si. Data are presented from recent calculations that give the average energy going into the electronic system and the average energy going into the atomic system per incident neutron as a function of neutron energy. These calculations, based on the experimental results of the energy partition of Si primaries in Si and recent neutron cross-section measurements in Si, are found to be in good agreement with each other. Average ionization measurements made as a function of neutron energy agree with the ionization calculations. New results for Ge, which include energy partition calculations as a function of neutron energy, are presented. These results are based on the energy partition of Ge primaries in Ge and recent neutron cross-section measurements in Ge. Carrier-removal measurements made as a function of neutron energy for Si and Ge show that the carrier-removal rate is proportional to the energy available for displacements, i.e., the energy that goes into the atomic system. The relationship between fission damage and damage from monoenergetic neutrons is discussed. The energy of a neutron that would produce the same average damage as fission neutrons is defined and is not unique in the case of silicon. (auth)

37013 ANNEALING OF p-TYPE GERMANIUM FOLLOWING ELECTRON IRRADIATION AT 77°K. Saito, H. (Osaka Univ.); Fukuoka, N.; Hattori, H.; Crawford, J. H. Jr. pp 232-7 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Isochronal annealing of radiation damage induced in gallium- or indium-doped germanium by 1.5-MeV electron irradiation at 77°K was studied by Hall-coefficient and resistivity measurements. Positions of the two trapping levels were determined to be $E_c - 0.16$ eV and $E_v + 0.16$ eV, respectively, in gallium-doped samples. A shallow trapping level in indium-doped samples was found to be located at about $E_c - 0.10$ eV. The difference in annealing stages between gallium- and indium-doped samples is also discussed. (auth)

37014 EXPERIMENTAL EVIDENCE FOR PRODUCTION AND ANNIHILATION OF INTERSTITIAL IMPURITIES IN ELECTRON-IRRADIATED n-TYPE GERMANIUM. Hiraki, A.; Cleland, J. W.; Crawford, J. H. Jr. (Oak Ridge National Lab., Tenn.). pp 224-31 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Investigation of the problem of interstitials and interstitial impurity atoms has been continued by means of electrical-property measurements in antimony-doped germanium. Working from the assumption that interstitial antimony (Sb_I), like substitutional antimony (Sb_S), is a donor, it was found that relaxation subsequent to irradiation, as well as the yield of stable defects in the room-temperature range, is consistent with the interpretation that Sb_I is produced and that there is competition between Sb_I and Sb_S for moving vacancies. Vacancy capture by Sb_I would cause defect annihilation while capture by Sb_S leads to stabilization. (auth)

37015 ENHANCED DIFFUSION IN GERMANIUM. Brelot, A. (Ecole Normale Superieure, Paris). pp 460-5 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

The dynamic behavior of radiation defects at high temperature (600°C) has been investigated by means of a substitutional-impurity

enhanced-diffusion study. After irradiation it is found that the impurity has diffused much faster than expected from thermal diffusion. This enhanced diffusion appears to be governed by diffusion in excess vacancies created by the irradiation. It is thus possible to measure a defect migration energy and a diffusion length. (auth)

37016 USE OF CHANNELING TO INVESTIGATE GALLIUM-IMPLANTED SILICON. Eriksson, L.; Davies, J. A.; Mayer, J. W. (Chalk River Nuclear Labs., Ont.). pp 398-405 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

The orientation dependence (channeling) of the scattering yield of 1.0-MeV He ions has been used to study Ga-implanted silicon. In this way, information has been obtained about both the lattice location of the Ga ions (implanted at 40 keV) and the annealing characteristics of the disordered regions created during the implantation. At room temperature an impinging heavy ion creates a highly disordered region around its track. At low fluence, the number of displaced lattice atoms is proportional to the number of implanted ions. At higher fluence, the total number of displaced atoms approaches a saturation value, owing to the overlap of the disordered regions to form an amorphous layer. This transition occurs around 10^{14} ions/cm^2. Temperatures above 600°C are required to anneal saturated samples, whereas the individual disordered regions occurring at low fluence are annealed at significantly lower temperatures (350°C). After annealing to 600°C, ≈30% substitutional Ga and ≈30% interstitial Ga were observed, indicative of the occurrence of pairing. Sb implantations exhibit a high (≈90%) substitutional level in annealed samples. For hot implantations (450°C) a high substitutional level was found in the case of Sb, but <10% substitutional in the case of Ga. This marked difference in behavior between Ga and Sb implants is attributed to the Si interstitial-impurity atom replacement mechanism, proposed by Watkins for certain Group-III elements such as Ga. (auth)

37017 HIGH-ENERGY NITROGEN DOPING OF SINGLE-CRYSTAL SILICON. Schwuttke, G. H. (International Business Machines Corp., East Fishkill, N. Y.); Brack, K.; Gardner, E. E.; DeAngelis, H. M. pp 406-17 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Silicon crystals bombarded with 2-MeV nitrogen ions are characterized through transmission electron microscopy, x-ray-diffraction topography, surface and in-depth conductivity measurements, and microsectioning techniques. From these measurements a buried layer is found with different mechanical, electrical, and chemical properties at a depth of 1.7 to 2.2 μ below the surface. Embedded in this layer are polycrystalline and amorphous regions. It is also shown that implanted nitrogen atoms have donor properties in p-type silicon. These properties are not apparent until radiation defects are annealed out. (auth)

37018 RADIATION DAMAGE IN Li-DOPED MnO. Nagels, P.; Ali, M.; Denayer, M. (SCK-CEN, Mol, Belg.). pp 452-9 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Measurements of electrical conductivity on Li-doped MnO before and after neutron irradiation show that the main effect of irradiation is to produce donor defect centers that partly compensate the chemical Li^+Mn^{+++} acceptors. The structural defects acting as donors are completely annealed out in the temperature range between 200 and 500°C (with an annealing peak at around 390°C). The activation energy for defect migration, determined from isochronal and isothermal anneals using the methods of Overhauser and Meechan–Brinkman, is equal to 1.8 ± 0.1 eV. (auth)

37019 X-RAY LATTICE-PARAMETER STUDIES OF ELECTRON-IRRADIATED SILICON. Moyer, N. E. (Purdue Univ., Lafayette, Ind.); Buschert, R. C. pp 444-51 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

X-ray lattice parameters have been measured in dislocation-free silicon to a sensitivity of $\Delta d/d = \pm 2 \times 10^{-8}$ by a new three-crystal method. Measured diffraction line widths of 0.14 to 0.16 second of arc are close to the theoretical value of 0.13, and no change is observed during irradiation or subsequent anneal. About 5×10^{16} carbon atoms/cm^3 have been detected in the Texas Instruments "Lopex" crystals. Room-temperature irradiation with 1-MeV electrons produces expansions of $\Delta d/d = +1 \times 10^{-7}$ in undoped "Lopex" and one-half of this for undoped Dow Corning "Perf-x" after a fluence of 3×10^{18} electrons/cm^2. Much larger increases are shown by n-type (As-doped) samples, but these samples show saturation with increasing fluence. The maximum or saturation value of the lattice-parameter increase is proportional to the arsenic concentration. A p-type (boron-doped) sample also shows an increased introduction rate and subsequent saturation. Isochronal annealing of both the n- and the p-type samples shows recovery stages in the 300 to 400°C and 600 to 700°C ranges. It is concluded that impurity atoms are necessary to trap radiation-induced defects in order to give an observed lattice-parameter change. (auth)

37020 EFFECTS OF IRRADIATION ON THE LUMINESCENCE OF GaAs AND OTHER III–V COMPOUNDS. Arnold, G. W.; Gobeli, G. W. (Sandia Lab., Albuquerque, N. Mex.). pp 435-43 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Fast-electron bombardment of GaAs, AlSb, and InP results in an exponential degradation of band-edge luminescence as a function of electron fluence. Bombardment of the (111) and ($\bar{1}\bar{1}\bar{1}$) faces of GaAs indicates that the displacement of As atoms is primarily responsible for the luminescence degradation. Irradiations of AlSb and InP also show the importance of the Group-V element in quenching radiative recombination. Degradation of the luminescence takes place at bombardment energies of about 280 keV and above. For the particular case of Zn-doped GaAs, a second, and higher, energy threshold is observed. This threshold is connected with the generation of sharp-line structure, which occurs upon irradiation followed by annealing near 200°C. This higher energy threshold corresponds to a lattice displacement energy of about 50 eV. It is suggested that the lower displacement energy of about 10 eV corresponds to the breakup of interstitial complexes (perhaps Ga–As pairs) and that the higher threshold is an effective value for direct lattice atom displacement. (auth)

37021 RECOMBINATION LUMINESCENCE OF IRRADIATED SILICON. Spry, Robert J.; Compton, W. Dale (Univ. of Illinois, Urbana). pp 421-34 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Numerous physical properties of semiconductors are affected by the point defects that are introduced by irradiation with neutrons or gamma rays. Studies of these properties have led to the establishment of the microscopic models for several of these defects This paper reports on the luminescence that arises from the recombination of electrons and holes at these defects. The details of this luminescence give information about the energy level arising from the defect and the nature of the interaction of the defect with the lattice. (auth)

37022 SUMMARY OF THE SANTA FE CONFERENCE. Crawford, J. H. Jr. (Univ. of North Carolina, Chapel Hill). pp 469-79 of Radiation Effects in Semiconductors. Vook, Frederick L. (ed.). New York, Plenum Press, 1968.

From Conference on Radiation Effects in Semiconductors, Santa Fe, N. Mex. See CONF-671058.

Past developments in the study of radiation effects on semiconductors are surveyed briefly. Research trends as presented at this conference are compared with those at previous conferences. Progress in various areas is pointed out, and some questions for future investigation are proposed. (A.G.W.)

37023 INFLUENCE OF HEAT TREATMENT AND IRRADIATION ON THE LUMINESCENCE OF NATURAL DIAMOND. Gerasimenko, N. N.; Il'in, V. E.; Lezheiko, L. V.; Smirnov, L. S.; Sobolev, E. V.; Yur'eva, O. P. (Inst. of Semiconductor Physics, Novosibirsk, USSR. Inst. of Inorganic Chemistry, Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 2898-9 (June 1968).

Translated from Fiz. Tverd. Tela, 9: 3665-8 (Dec. 1967).

Diamonds of various types were irradiated with 3.5-MeV electrons in doses up to 3×10^{17} electrons/cm^2 and annealed in the range 400 to 800°C. Luminescence spectra were excited by application of electron pulses and by illumination with a group of mercury lines at 365 mμ. It was found that considerable changes in the luminescence spectra were due to the heat treatment itself without any previous irradiation. Previous irradiation enhanced the effect of heat treatment. (A.G.W.)

37024 ANGULAR DEPENDENCE OF THE RADIATION-INDUCED CONDUCTIVITY AND SECONDARY EMISSION DUE TO BOMBARDMENT OF A Ge SINGLE CRYSTAL WITH ELECTRONS. Abroyan, I. A.; Titov, A. I. (Polytechnic Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 9: 2860-1 (June 1968).

Translated from Fiz. Tverd. Tela, 9: 3628-30 (Dec. 1967).

The dependence of the radioinduced conductivity and the secondary electron emission coefficient of p-type germanium single crystals on the angle of incidence of a beam of primary electrons was investigated. A nonmonotonic dependence was found in both cases. The conductivity dependence had many minima, and the positions of the strongest minima coincided with the crystallographic directions [112], [110], [123]. The secondary emission dependence had maxima in positions coinciding with the minima in the conductivity dependence curve. The similar dependences were reproducible and were found for different sides of the same target and for different targets. (A.G.W.)

37025 RADIOCHEMICAL REDUCTION OF MeF_2–RE^{3+} CRYSTALS. Arkhangel'skaya, V. A.; Kiseleva, M. N. Sov. Phys.-Solid State (Engl. Transl.), 9: 2774-6(June 1968).
Translated from Fiz. Tverd. Tela, 9: 3523-6(Dec. 1967).

The kinetics of the disintegration of separate types of Eu^{3+} centers and the formation of Eu^{2+} during the radiochemical reduction of CaF_2-Eu^{3+} at 300°K is studied on the basis of a method developed by the authors for determining the concentration of bivalent rare earth ions in crystals of the fluorite type. It is shown that the formation of Eu^{2+} ions is limited by the deexcitation effect of hard radiation, and that the observed changes in the concentrations of the separate types of Eu^{3+} centers are associated not with electronic but with intense ionic processes occurring in MeF_2 under the influence of γ radiation. (auth)

37026 COALESCENCE OF A SYSTEM OF DISLOCATION LOOPS AND PORES IN MATERIALS SUBJECTED TO IRRADIATION. Slezov, V. V. (Inst. of Physics and Tech., Kharkov). Sov. Phys.-Solid State (Engl. Transl.), 9: 2720-4(June 1968).
Translated from Fiz. Tverd. Tela, 9: 3448-55(Dec. 1967).

Pores have been considered concurrently with dislocation loops under conditions of irradiation in which gas atoms are also formed. A complete system of equations describing them is obtained. The changes with time of the mean pore size, dislocation loops, and concentration of gas atoms, the effective supersaturation of point defects, and the volume of the specimen have been found. (auth)

37027 INVESTIGATION OF THE DISTRIBUTION OF BORON ATOMS IN SILICON DOPED BY ION BOMBARDMENT. Zorin, E. I.; Pavlov, P. V.; Tetel'baum, D. I. (Gorkii State Univ., USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 2874-6(June 1968).
Translated from Fiz. Tverd. Tela, 9: 3642-4(Dec. 1967).

The distribution of boron atoms introduced into Si by bombardment by 20- to 60-keV ion beams was investigated in cases of random and aligned (111) orientation of the ion beam. Results were compared with previous calculations of the distribution. In the case of random orientation, the experimental data agree with the calculations within the limits of error of the measurement. Significant deviations between experimental and calculated curves in the case of (111) orientation indicate development of the channeling effect. (A.G.W.)

37028 EXCHANGE INTERACTION OF F CENTERS IN NEUTRON-IRRADIATED LITHIUM FLUORIDE AND HYDRIDE. Pilipenko, G. I.; Gavrilov, F. F.; Chirkov, A. A.; Solodov, V. P.; Yumashev, Yu. M. (Ural Polytechnic Inst., USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 2877-8(June 1968).
Translated from Fiz. Tverd. Tela, 9: 3645-6(Dec. 1967).

Single crystals of LiF and LiH were irradiated with neutrons in a thermal reactor. The integrated flux varied from 6×10^{14} to 10^{17} n/cm^2. Studies of the EPR spectra showed that the EPR signal width decreased with increasing radiation dose. Previously described techniques were used to calculate the frequency of the exchange interaction between F centers as a function of the separation between the centers. It is concluded that the observed narrowing of the EPR signal width in LiF and LiH following neutron irradiation can be explained satisfactorily as being caused by the exchange interaction between F centers. (A.G.W.)

37029 INELASTIC ENERGY LOSS OF IONS IN CHANNELS IN CRYSTALLINE MATERIALS. Martynenko, Yu. V. Sov. Phys.-Solid State (Engl. Transl.), 9: 2879-80(June 1968).
Translated from Fiz. Tverd. Tela, 9: 3646-9(Dec. 1967).

The calculation of the inelastic energy loss of ions moving near the axis of channels in metals is described. When the method is applied to Cu, it is seen that for metals the energy loss by electron excitation can exceed the loss due to elastic collisions. When the motion of an ion in a semiconductor is considered, it is found that the energy loss by electron excitation is several orders of magnitude less than the elastic loss. (A.G.W.)

37030 ELECTRICAL PROPERTIES OF CERIUM DIOXIDE SINGLE CRYSTALS. Vinokurov, I. V.; Zonn, Z. N.; Ioffe, V. A. (Inst. of Silicate Chemistry, Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 9: 2659-63(June 1968).
Translated from Fiz. Tverd. Tela, 9: 3369-74(Dec. 1967).

Electrolytic reduction of CeO_2 single crystals was investigated. A quantitative estimate of the anion component of the current was obtained from the change in the pressure in a sealed container when a current was passed through a crystal. The results obtained were used to derive a model of the conduction mechanism, which described qualitatively the observed phenomena. (auth)

37031 SPECIFIC HEAT OF TUNGSTEN–RHENIUM ALLOY VR-20 IN THE 1600 TO 2900°K RANGE. Sukhovei, K. S. Sov. Phys.-Solid State (Engl. Transl.), 9: 2893-5(June 1968).
Translated from Fiz. Tverd. Tela, 9: 3660-3(Dec. 1967).

A modulation method was used to measure the specific heat of a W−20% Re alloy from 1600 to 2900°K. Comparison of the results with results for pure W showed that the specific heat of the alloy was very close to that of W, but at moderate temperatures it varied more slowly with temperature. (A.G.W.)

37032 EFFECT OF FAST NEUTRON IRRADIATION ON DISLOCATION DENSITY IN SILICON. Makarevich, A. I.; Raines, L. Yu.; Kovtanyuk, N. F.; Berezine, G. M.; Kurilovich, N. F. (Inst. of Physics of Solids and Semiconductors, Acad. of Sciences, BSSR). Dokl. Akad. Nauk BSSR, 12: 219-21(Mar. 1968). (In Russian).

The effect of fast neutron irradiation on the dislocation density in oxidized and superpure silicon was studied by the calculation of the corrosion pits. It was established that with increase of the fast neutron dose the dislocation density in the samples monotonously increases. The effect of the original dislocation density and of the irradiation temperature (56 to 140°C) on the absolute growth of the dislocation density and its comparative density during saturation were investigated. It was assumed that the formation of the new dislocations arises as the result of interactions of the initial radiation defects with the dislocations formed in the sample by irradiation. (tr-auth)

37033 COMPUTER STUDIES OF CHANNELING OF IONS IN ALKALI HALIDE LATTICES. Torrens, Ian McC.; Chadderton, Lewis T. (North American Aviation Science Center, Thousand Oaks, Calif.). Can. J. Phys., 46: 1303-9(June 1, 1968).

The channeling of potassium, sodium, and chlorine ions in potassium chloride and sodium chloride has been investigated by computer simulation techniques. With the model chosen, axial and interplanar channeling occurs for potassium and chlorine ions in potassium chloride and for the smaller sodium ion in sodium chloride. Some events indicate the possibility that energetic sodium ions are displaced from their lattice sites into channels. The channeling process, especially at higher energies, is relatively insensitive to reasonable variations in the ionic interaction potential. (auth)

37034 POINT-DEFECT PINNING OF DISLOCATIONS DURING INITIAL PERIOD OF CONTINUOUS LOW-LEVEL GAMMA IRRADIATION: APPLICATION TO STAGE III IN COPPER. Meisel, L. V. (Watervliet Arsenal, N. Y.); Thompson, D. O. J. Appl. Phys., 39: 3447-9(June 1968).

The pinning of dislocations by point defects formed during continuous low-level irradiation is studied for short times. On the basis of stress-assisted diffusion theory it is shown that the number of point defects which arrive at dislocations should be proportional to the 5/3 power of the irradiation time (for short times). These results are applied to stage III measurements in copper. The migration energy and (formation) volume determined from the transient data are 0.61 ± 0.04 eV and $(0.45 \pm 0.23) \times 10^{-23}$ cm^3, respectively. (auth)

37035 ABSENCE OF PARAMAGNETIC NEUTRON SCATTERING IN V_3Si. Vance, E. R.; Finlayson, T. R. (Monash Univ., Victoria, Australia). J. Appl. Phys., 39: 3501-2(June 1968).

To obtain further evidence that the d electrons are indeed in the conduction band in V_3Si, a search was made for paramagnetic neutron scattering at room temperature in this material. No paramagnetic scattering was observed. (M.H.R.)

37036 THE ENTROPY ASSOCIATED WITH THE MAGNETIC TRANSITIONS OF THE HCP RARE EARTH METALS. Smith, David (Brooklyn Coll., N. Y.). Scr. Met., 1: 157-60(Dec. 1967).

The low-temperature heat capacity of hcp metals is fitted by $C_p = C_q + \gamma T + (aC_q)^2 T$, where $C_q = 3D(\theta/T)$. Heat capacity parameters (K, θ, a, γ) are tabulated for 12 hcp metals. By assuming K = 127 and a = 0, magnetic heat capacity and entropy are calculated for the hcp rare earth metals (Dy, Er, Gd, Ho, Tb, Tm). The extrapolated entropy $S(T = \infty)$ is in excellent agreement with the expected values (R ln(2J + 1)), except for Er. (D.L.C.)

37037 ANISOTROPY OF MAGNETIZATION AND MAGNETOSTRICTION OF SINGLE CRYSTALS OF Tb, Dy, Er, AND Gd IN PULSED FIELDS UP TO 150 kOe. Belov, K. P.; Levitin, R. Z.;

Ponomarjov, B. K. (Moscow State Univ.). J. Appl. Phys., 39: 3285-6(June 1968).

The uniaxial anisotropy and magnetostriction along the hard direction of single crystals of Gd, Tb, Dy, and Er were measured in pulsed fields up to 150 kOe. The magnetic anisotropy and magnetostriction are very large for Tb, Dy, and Er; with effective anisotropy fields considerably greater than 150 kOe. In Gd the magnetic anisotropy and magnetostriction are two orders of magnitude smaller. (auth)

37038 ELECTRICAL RESISTIVITY OF SOME DILUTE GOLD–RARE EARTH ALLOYS. Edwards, L. Roger; Legvold, Sam (Ames Lab., Iowa). J. Appl. Phys., 39: 3250-2(June 1968). (IS–1628).

The electrical resistivity has been measured from 1.3° to 20°K on solid solutions of Gd, Tb, and Ho in Au. It was found that the resistivity decreased with decreasing temperature with no evidence of a resistance minimum. However, the resistivity showed a more pronounced decrease in the temperature range 6° to 3.5°K. These results are discussed in terms of the Kondo theory. It was also found that the residual resistivity, $\rho(4.2°K)$, is proportional to the concentration of rare earths for the Gd, Tb, and Ho alloys. Furthermore, the proportionality constant is the same for the three sets of alloys indicating ionic (trivalent) scattering as the main contribution to the residual resistivity. (auth)

37039 THIRD-ORDER ELASTIC CONSTANTS OF SINGLE-CRYSTAL AND POLYCRYSTALLINE COLUMBIUM. Graham, L. J.; Nadler, H.; Chang, Roger (North American Rockwell Corp., Thousand Oaks, Calif.). J. Appl. Phys., 39: 3025-33(June 1968).

The second-order and third-order elastic constants for both single-crystal and polycrystalline niobium were determined at 298°K using an ultrasonic phase comparison method. It is shown that any dislocation contribution to the measurements is negligible with respect to other uncertainties. The third-order elastic constants (Brugger convention) in units of 10^{12} dyn/cm^2 are given. The Grueneisen parameter calculated from these values is 1.511 ± 0.026 for the single crystal, and 1.546 ± 0.092 for the polycrystal, in good agreement with the value 1.52 calculated from bulk-property measurements. The polycrystalline third-order elastic constants are in very good agreement with those calculated from the single-crystal values by the method of Chang. (auth)

37040 ENERGY DEPENDENCE OF DAMAGE RECOVERY IN n-TYPE Ge ELECTRON-IRRADIATED AT 4.2°K. Penczer, Rudolf E.; DeAngelis, Henry M. (Air Force Cambridge Research Labs., Bedford, Mass.). Phys. Rev., 171: 862-6(July 15, 1968).

Damage produced in n-type Ge by electron irradiation partially anneals in two stages centered near 35 and 65°K. A small but constant reduction in conductivity is produced by bombardment with electrons with energies from 0.7 to 1.2 MeV. The fraction of the radiation-induced conductivity change recovered in each stage is observed as a function of electron energy for a sample with little residual damage and for one with large residual damage. The 65°K defect recovery increases with energy in both cases. This result is explained on the basis of radiation modification of 65°K defects. The 35°K defect recovery versus energy peaks in both cases. The dropoff at low energy is explained as being due to radiation annealing. The dropoff at high energies is explained as being due to the decrease in the modification of 65°K defects to 35°K defects in the sample with little residual damage. In the sample with considerable residual damage it is suggested that production of 35°K defects as primary defects decreases with increasing energy. Results are consistent with the model proposed by MacKay and Klontz with the addition that the 65°K defect can be modified to the 35°K defect by ionization of one of the two electrons trapped by the 65°K defect. (auth)

37041 CHARACTERISTICS OF NEUTRON DAMAGE IN SILICON. Cheng, L. J.; Lori, J. (Chalk River Nuclear Labs., Ont.). Phys. Rev., 171: 856-62(July 15, 1968).

The production and annealing behavior of the divacancy and the A center in fission-neutron-irradiated silicon was studied by infrared absorption, using the 1.8-, 3.9-, and 12-μ bands. The production rate of the divacancy was found to be high, about 5.7 cm^{-1}, and to be enhanced by the presence of boron ($\sim 2 \times 10^{17}$ atoms per cm^3), but not by the presence of oxygen ($\sim 1 \times 10^{18}$ atoms per cm^3). The annealing of divacancies in neutron-irradiated Si required an activation energy of 1.25 eV, as in electron-irradiated Si, indicating that most of the divacancies were removed by diffusion to sinks. The annealing results also indicate that the local defect concentrations in the damaged regions can be as high as $\sim 10^{20}$ defects cm^{-3}, in which the divacancies still retain their individual properties as far as their infrared absorption and annealing properties are concerned. The production rate of the A center was found to be extremely low. The near-edge absorption band was also studied. About 95% of the near-edge band disappeared upon annealing in the same broad temperature range as did the divacancies. From these results, it was concluded that the majority of the total volume in localized damage regions produced by the fission-neutron irradiation of silicon is rich in divacancies and is still crystalline. (auth)

37042 INFRARED DISPERSION AND LATTICE VIBRATIONS OF LaF_3. Rast, H. E. (Naval Weapons Center Corona Labs., Calif.); Caspers, H. H.; Miller, S. A.; Buchanan, R. A. Phys. Rev., 171: 1051-7(July 15, 1968).

The infrared spectral emittance of oriented single crystals of LaF_3 has been measured in the range 4 to 125 μm. Eleven transitions have been identified whose net moments are perpendicular to the optic axis (E_u:x,y), and five additional bands were observed having net moments parallel to the optic axis (A_{2u}:z). The data, taken near 4.2, 77, and 373°K, were treated by Kramers–Kronig analysis and by classical oscillator dispersion theory. The results support a crystal structure of $D_{3d}^5(P\bar{3}c1)$, which is very slightly distorted from a unit cell of $D_{6h}^2(P6_3/mcm)$ symmetry. The infrared results are in good agreement with the results of a recent Raman investigation of LaF_3. (auth)

37043 THE CRYSTAL STRUCTURE OF $La_2Be_2O_5$. Harris, L. A.; Yakel, H. L. (Oak Ridge National Lab., Tenn.). Acta Crystallogr., B24: 672-82(1968).

The crystal structure of $La_2Be_2O_5$ was derived and refined from Mo Kα x-ray diffraction data. The C-centered monoclinic unit cell with $a_0 = 7.536$, $b_0 = 7.348$, $c_0 = 7.439$ Å, $\beta = 91°33'$ contains four formula weights. The atomic arrangement in this equilibrium phase consists of a three-dimensional framework of corner-sharing beryllium–oxygen tetrahedra with lanthanum atoms irregularly coordinated to ten oxygen atoms. The structure is compared with those of other oxide compounds containing beryllium and, in particular, with the structures of the recently reported nonequilibrium phases $Ca_{12}Be_{17}O_{29}$ and Y_2BeO_4. (auth) (Denmark)

37044 LATTICE DYNAMICS OF NIOBIUM–MOLYBDENUM ALLOYS. Powell, B. M.; Martel, P.; Woods, A. D. B. (Chalk River Nuclear Labs., Ont.). Phys. Rev., 171: 727-36(July 15, 1968).

The frequency-versus-wave-vector dispersion relations for the normal modes of vibration of a series of alloys of the transition metals niobium and molybdenum have been measured at 296°K, and previous measurements on the pure metals have been extended, using coherent one-phonon scattering of thermal neutrons. The phonon dispersion relations are very different for the two pure metals, suggesting that the electronic structure, acting through the electron–phonon interaction, plays a significant role in the determination of the dynamics of these materials. The observed neutron groups corresponding to the phonons in the alloys are not significantly broader than in the pure metals. The dependence of the dispersion curves on alloy composition is found to be complicated, both the general level of frequencies and the shape of the curves changing significantly. Fourier analysis indicates that the interatomic forces in the metals are oscillatory and of long range. Suspected Kohn anomalies are observed on several branches of the dispersion curves. With the assumption of a rigid-band model, the positions of several of these anomalies correlate with the calculated electron band structure for tungsten. The dimensions of the Fermi surface obtained from this correlation are in agreement with other Fermi-surface information. (auth)

37045 LATTICE DISORDER IN ALKALI METAL HALIDES X-IRRADIATED AT ROOM TEMPERATURE. Balzer, R.; Peisl, H.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Phys. Status Solidi, 28: 207-10(July 1, 1968).

Combined measurements of lattice-parameter and length change give evidence that in the alkali metal halides KBr, LiF, KCl, NaF, and NaCl Frenkel disorder is present after x irradiation at room temperature. (auth)

37046 EFFECT OF REACTOR IRRADIATION ON THE CONDUCTIVITY AND THE PHOTOCONDUCTIVITY OF HEXAGONAL SELENIUM SINGLE CRYSTALS. Tuomi, T. O. (Technical Univ. of Helsinki). Phys. Status Solidi, 28: 329-34(July 1, 1968).

Radiation damage in selenium is investigated at various temperatures. Fast-neutron irradiation is found to decrease the conductivity of a hexagonal selenium single crystal at 310°K in an exponential manner. According to the barrier model the decrease of the conductivity is a result of the decrease in the hole concentration in the high-conductivity regions. The photoconductivity measurements indicate that the fast-neutron irradiation does not markedly change the properties of the barriers. At 80°K the crystals are more sensitive to radiation than at 310°K, whereas at 20°K the effect of radiation on the conductivity is of the same order as at room temperature. (auth)

37047 ELECTRON DIFFRACTION AND ELECTRON MICROSCOPIC STUDY OF LONG- AND SHORT-RANGE ORDER IN Ni_4Mo AND OF THE SUBSTRUCTURE RESULTING FROM ORDERING. Ruedl, E.; Delavignette, P.; Amelinckx, S. (SCK–CEN, Mol, Belg.). Phys. Status Solidi, 28: 305-28(July 1, 1968).

The ordering process in Ni_4Mo gives rise to three different classes of interfaces within a single crystal of the basic structure. The geometry of these interfaces and the diffraction effects to be expected from them are discussed. Evidence for the different classes of interfaces is given. The interfaces resulting from slip are discussed and compared with the observations. Quenched specimens exhibit short-range order. A model for short-range order in this alloy is presented. Preliminary experiments indicate that quenched Ni_3Mo also shows short-range order of a type similar to Ni_4Mo. (auth)

37048 NORMAL SPECTRAL EMISSIVITY OF TUNGSTEN–MOLYBDENUM ALLOYS. Thomas, L. K. (Westinghouse Research and Development Center, Pittsburgh). Phys. Status Solidi, 28: 401-6(July 1, 1968).

Results of investigations of the normal spectral emissivity of W–Mo alloys are reported. The measurements were made at 2000, 2200, and 2400°K in the wavelength range 0.4 to 4 μm. Emissivity values of the alloys lie between those of the pure constituents. The temperature coefficient of the emissivity and the x-point position change with composition. The results are discussed in terms of the rigid band model. (auth)

37049 NOTE ON MOESSBAUER EFFECT IN $MnFe_2O_4$. Bunget, I. (Univ. of Bucharest). Phys. Status Solidi, 28: K39-42(July 1, 1968).

It is suggested that the large dispersion of experimental data reported by different investigators on internal effective fields at iron nuclei in Moessbauer studies is due to the use of samples with different amounts of Fe^{2+} incorporated during preparation. Sample preparations and calculations of internal effective fields on octahedral sites and tetrahedral sites are discussed briefly in support of the suggestion. (A.G.W.)

37050 THERMOLUMINESCENT SPECTRA AND TRANSITION KINETICS OF γ-RAY COLORED SYNTHETIC CaF_2 SINGLE CRYSTAL. Nakajima, Toshiyuki (National Inst. of Radiological Science, Chiba, Japan). Jap. J. Appl. Phys., 7: 759-63(July 1968).

The thermoluminescent spectra of synthetic CaF_2 single crystals irradiated with γ rays were investigated. Emission peaks were observed at 382, 416, 438, 481, 549, 577, 647, and 838 mμ. Wavelengths of these peaks did not vary with the increase of the temperatures from room temperature up to 700°K. Glow curves for spectral emission peaks were recorded throughout the temperature range between 300°K and 700°K. The thermal activation energies in the spectral glow were not constant. The shapes of the glow curves indicated that thermoluminescence of the emissions at 382, 416, 438, 481, 549, and 577 mμ occurred with bimolecular process. (auth)

37051 MAGNETIC ORDERING IN THE RARE-EARTH HEXABORIDES. Geballe, T. H.; Matthias, B. T.; Andres, K.; Maita, J. P.; Cooper, A. S.; Corenzwit, E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Science, 160: 1443-4(June 28, 1968).

Magnetic ordering in the rare-earth hexaborides was studied by a variety of methods, and a clear correlation with the presence of conduction electrons was found. (auth)

37052 rf-INDUCED SIDEBANDS IN MOESSBAUER SPECTRA. Heiman, Neil D.; Pfeiffer, Loren; Walker, J. C. (John Hopkins Univ., Baltimore). Phys. Rev. Lett., 21: 93-6(July 8, 1967).

The first clear evidence that rf magnetic fields generate acoustical sidebands in the Mössbauer spectra of metallic ^{57}Fe is reported. An explanation of this magnetoacoustic effect in terms of magnetostriction is presented. It is suggested that this effect provides a consistent explanation of the results of several workers who observed rf resonance effects seemingly associated with hyperfine transitions. (auth)

37053 FORMATION OF ELECTRON CENTERS IN POLYCRYSTALLINE NaCl AND $SrCl_2$ DURING ^{60}Co γ IRRADIATION. Rabe, J. G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 23a: 186-90(Jan. 1968). (In German).

The concentration of electron centers in polycrystalline NaCl and $SrCl_2$ was determined by measuring the amount of hydrogen which is evolved when the irradiated salt is dissolved in an acid aqueous solution containing alcohol. The time dependence of the formation of electron centers can be described by the same equation as was derived for F centers in single crystals of NaCl and KCl. Grinding of salt results in the formation of additional negative-ion vacancies in the lattice. Their concentration can be determined from the growth curve of the electron centers. Grinding increased the concentration of negative-ion vacancies by about one order of magnitude. For polycrystalline $SrCl_2$ a growth curve of electron centers similar to that of NaCl is obtained. In annealed samples of $SrCl_2$ (750°C) the concentration of electron centers is one to two orders of magnitude lower at the same dose than in samples which have not been annealed. (auth)

37054 AMORPHIZATION UNDER IRRADIATION OF A PALLADIUM–SILICON ALLOY. Lesueur, Daniel (CEN, Fontenay-aux-Roses, France). Compt. Rend., Ser. A and B, 266: 1038-41(Apr. 8, 1968). (In French).

A Pd–Si alloy with 20 at. % Si was irradiated with ^{235}U fission products. It was shown by x-ray diffraction that it becomes amorphous. The resistivity variation during the irradiation was measured and the action volume of a fission particle was determined to be 2×10^{-17} cm^3. (tr-auth)

37055 MAGNETIC PROPERTIES AND MAGNETIC STRUCTURE OF THE COMPOUND HoAl. Becle, Christian; Lemaire, Remy; Pauthenet, Rene (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France. CENG, Grenoble, France). Compt. Rend., Ser. A and B, 266: 994-7(Apr. 8, 1968). (In French).

The compound HoAl, isotype of DyAl, is the only ferromagnetic compound among the equiatomic compounds of Al with the rare earths; its Curie temperature is 26°K. Neutron-diffraction studies show the existence of a non-colinear arrangement of the moments with a ferromagnetic component parallel to the b axis of the crystal. (tr-auth)

37056 A CONVENIENT SOURCE OF NEARLY MONOCHROMATIC LINEARLY POLARIZED ^{57}Fe GAMMA-RAYS. Housley, R. M. (North American Rockwell Corp., Thousand Oaks, Calif.). Nucl. Instrum. Methods, 62: 321-2(July 1, 1968).

A simple method of obtaining monochromatic linearly polarized γ rays by filtering out one quadrupole component of the radiation from a source of ^{57}Co in an oriented Be crystal is described. (auth)

37057 NUCLEAR DEMAGNETIZATION IN TRANSITORY REGIME IN THE ROTATING FRAME OF REFERENCE. APPLICATIONS TO NUCLEAR MAGNETIC RESONANCE IN WEAK FIELDS. Bene, Georges J. (Institut de Physique Experimentale, Geneva, Switzerland). Compt. Rend., Ser. A and B, 266: 1168-9(Apr. 22, 1968). (In French).

The resonating excitation of nuclei during the free precession phase in the transitory observation of the nuclear magnetic resonance after depolarization can permit an attenuation of the resonance lines of the order of $(\gamma T_1)^{-1}$ (γ is the gyromagnetic ratio of the nucleus and T_1 is the spin–lattice relaxation time) and a fast measurement of the spin–lattice relaxation in rotating frame of reference. (tr-auth)

37058 NMR BAND HANDBOOK. Szymanski, Herman A.; Yelin, Robert E. New York, IFI/Plenum Data Corp., 1968. 444p.

The significant bands in the NMR spectra of some 1200 compounds are indexed according to an alphanumeric code based on structural configuration. Entries with the same code designation are arranged in order of increasing chemical shift. Each entry tabulates all the bands that appear in the spectrum of the compound, which is identified by its structural formula. The coding of protons is that used in the Varian catalogs and a complete recapitulation of the code is presented on a foldout page that may be kept in view at all times. (M.H.R.)

Theoretical Physics

Refer also to abstract 37396.

37059 (AD–666943) BOUNDARY EFFECTS ON THE ENERGY LOSS OF CHARGED PARTICLES. Stern, Edward A. (RAND Corp., Santa Monica, Calif.). Apr. 4, 1961. 57p. (P–2270). CFSTI.

The energy loss of a charged particle moving at a constant velocity and passing normally through the boundary between two dielectric media is calculated. Attention is focused on the effects of the boundary and it is shown that the boundary creates two new mechanisms for losing energy. These are transition radiation and surface plasma oscillations. In addition, there are boundary corrections to the losses that are suffered by the particle in passing through the bulk material which are only important if the path length in the medium is of the order of the wavelength associated with the energy loss. The initiation of the emission of Čerenkov radiation as the particle first enters a medium is also studied in detail. (auth) (USGRDR)

37060 CHARGED-PARTICLE MOTION IN LARGE-AMPLITUDE ELECTROMAGNETIC FIELDS. Jory, H. R. (Varian

Associates, Palo Alto, Calif.); Trivelpiece, A. W. J. Appl. Phys., 39: 3053-60(June 1968).

The relativistic motion of a charged particle in large amplitude, inhomogeneous electromagnetic fields is studied for several situations. This study involved the numerical integration of the equations of motion including the relativistic mass correction and the nonlinear rf $v \times B$ force term. The cases studied include particle motion in linearly and circularly polarized, homogeneous plane waves with a homogeneous steady magnetic field parallel to the direction of propagation; particle motion in linearly and circularly polarized TE-11 modes in waveguides of circular cross section immersed in a uniform steady axial magnetic field; and particle motion in cavity resonators of circular cross section (TE-111 mode) immersed in a nonuniform steady axial magnetic field. This study is concerned with the maximum energy gains possible in the above situations with field amplitudes appropriate to high-power microwave experiments. To verify the features of the particle motion as predicted in the numerical study, and to investigate effects which could not be easily included in the analysis, such as space charge from the electron beams, beam-induced cavity fields, and ionization of residual gas in a cavity resonator, certain experiments were performed. These involved the injection of 1 to 100-mA electron beams at 100 to 1000 V on the axis of circular cross-section cavity resonators (10 GHz and 1.0 GHz) immersed in a steady axial magnetic field. With pulsed operation, an energy increase of 460 keV was obtained for a drive power of 46 kW at an overall efficiency of acceleration of approximately 10%. Higher-efficiency pulsed operation and continuous operation at lower power levels were also investigated experimentally. (auth)

37061 ELECTROMAGNETIC SCATTERING BY A MOVING SMALL PARTICLE. Shiozawa, T. (Osaka Univ.). J. Appl. Phys., 39: 2993-7(June 1968).

The problem of scattering of a plane electromagnetic wave by a small particle which is moving uniformly in vacuum is investigated. On the basis of the covariance of Maxwell's equations and the principle of phase invariance, the scattered field and the scattering cross section are obtained for a small particle with spherical symmetry which is composed of an arbitrary isotropic material. Then the general scattering formula is applied to the following four cases: (a) a dielectric or permeable particle, (b) a perfectly conducting particle, (c) a charged particle, and (d) a plasma particle. It is found that the scattered radiation is concentrated, in general, in the direction of motion. In addition, it is shown that the scattering cross section increases monotonically with the increase of the velocity when a particle is moving toward the incident wave, while it decreases monotonically when it is moving away from the incident wave. (auth)

37062 SINGLE-PARTICLE CONDENSATE AND PAIR THEORY OF A HOMOGENEOUS BOSON SYSTEM. Kobe, Donald H. (Oersted Institutet, Copenhagen). Ann. Phys. (N. Y.), 47: 15-39 (1968).

A canonical transformation which takes into account both pair correlations and the single-particle condensate is made on the full Hamiltonian for a system of interacting bosons, and the quasi-particle interactions are neglected. The theories of Bogolyubov Valatin and Butler, Brueckner and Sawada, and Etters can be obtained as special cases of the theory under certain approximations which are critically examined. A delta function potential which describes a soft spherically symmetric shell around a particle is used to reduce the complicated coupled integral equations to coupled equations for parameters. The formula for the quasi-particle energy is used to fit the experimental excitation spectrum, and good agreement in both the phonon and roton regimes is obtained with three parameters. An effective mass approximation is made to derive the empirical formula used by Larsson and Otnes to fit their neutron scattering data. (auth)

37063 A NEW APPROACH TO CHANDRASEKHAR'S SCATTERING MATRIX FOR A SEMI-INFINITE RAYLEIGH-SCATTERING ATMOSPHERE. Siewert, C. E. (North Carolina State Univ., Raleigh). Astrophys. J., 152: 835-40(June 1968).

A set of switched products between the half-range adjoint solutions and the eigenfunctions of the vector equation of transfer for two components of a Rayleigh-scattered radiation field is given. These scalar products are then used to develop Chandrasekhar's scattering matrix, which can be used to determine the emergent angular distribution for any of the standard half-space problems. As an example, the exit distribution for the Milne problem is obtained. (auth)

37064 ON THE EDDINGTON APPROXIMATION. Huang, Su-shu (Northwestern Univ., Evanston, Ill.). Astrophys. J., 152: 841-5(June 1968).

The Eddington approximation introduced for solving the equation of radiative transfer is formulated in such a way that it becomes meaningful to discuss different orders of approximation. At the same time, it adheres to Eddington's basic assumption of evaluating moments by an averaging process. (auth)

37065 STUDIES OF FEYNMAN ONE- AND TWO-ORDER DIAGRAMS FOR CERTAIN LIGHT ATOM STATES. II. RADIAL INTEGRALS. Ivanova, A. N.; Safronova, U. I.; Ivanov, L. N.; Tolmachev, V. V. Liet. Fiz. Rinkinys, Liet. TSR Moksiu Akad., Liet. TSR Aukst. Mokyklos, 7: 285-97(1967). (In Russian).

Radial integrals with one- or two-discrete or continuous parameters were studied. Numerical data were found for all one- and two-dimensional sums of radial integrals which are imperative for calculations of ground and excited states of light atoms. (tr-auth)

37066 TRANSIENT ASPECTS OF TRANSITION RADIATION. Ott, E.; Shmoys, J. (Polytechnic Inst. of Brooklyn). Quart. Appl. Math., 25: 377-98(Jan. 1968).

When a charged particle moving at uniform velocity crosses a boundary between two media with different electrical properties, a pulse of electromagnetic energy is emitted. The charge will radiate even though it does not accelerate or move faster than the phase velocity of light in the medium. The effect is fundamentally a transient process. For the specific problem selected, an exact closed form solution is obtained in a form amenable to physical interpretation. Before the time of impact the entire field may be represented in terms of an image picture, a generalization of the static case; after impact the image picture remains valid only in certain regions of space. At impact, a sudden burst of energy is liberated. This energy then propagates outward from the impact point. A representation of the solution in terms of Fourier integrals is obtained; these are then reduced to such a form that they can be evaluated by inspection. (BBB)

37067 A CONTRIBUTION TO THE KNOWLEDGE OF ANTI-MATTER (PRELIMINARY COMMUNICATION). Mohorovicic, Stjepan (St. Tisza Scientific Society, Debrecen, Hungary). Rev. Real Acad. Cienc. Exact. Fis. Nat. Madrid, 61: 545-54(1967).

Knowledge relating to the 2 kinds of matter, common matter and antimatter, is discussed. The nuclei of the atom of common matter are composed of subparticles, moving inside the atomic nucleus at velocities of $v < c$. In comparison with that the atomic nuclei of antimatter are composed of subparticles moving inside the atomic anti-nuclei at a higher velocity ($w > c$) than the velocity of light. Such antisubparticles are denoted as contrary matter. When a collision of common matter and antimatter occurs, both are annihilated. It is shown that antimatter possesses a negative mass, an assumption in keeping with the special theory of relativity. It is shown that the highest possible velocity of antimatter in the context of the special theory of relativity is $w \leq c \times \sqrt{2}$. (BBB)

37068 CRITICAL REMARK ON THE OBSERVABILITY OF THE SIGN CHANGE OF SPINORS UNDER 2π ROTATIONS. Hegerfeldt, G. C.; Kraus, K. (Univ., Marburg, Ger.). Phys. Rev., 170: 1185-6(June 25, 1968).

In a recent paper, Aharonov and Susskind claimed rotations by 2π to have observable effects on spinors. Their reasoning is shown to be inconclusive. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 37091 and 37092.

Electromagnetic

37069 (NP–17458) PROPOSTA DI ESPERIENZA PER LA MISURA DELLA SEZIONE D'URTO DI FOTOPRODUZIONE DI PIONI NEGATIVI SU NEUTRONI IN DEUTERIO. (Proposal for an Experiment for the Measurement of the Collision Cross Section for Photoproduction of Negative Pions by Neutrons in Deuterium). Note No. 110. Beneventano, M.; Del Priori, M.; de Notaristefani, F.; Monacelli, P.; Paoluzi, L.; Sebastiani, F.; Severi, M. (Rome Univ. (Italy). Istituto di Fisica). Dec. 16, 1966. 21p. (In Italian). Dep.

An experiment is described for the measurement of the cross section of the reaction $\gamma + n \rightarrow \pi^- + p$ at fixed angle of emission of π^- in the pion-nucleon cms system for incident γ energy between 500 and 800 MeV. The kinematics of the process are calculated and the results are graphed. The experimental apparatus is sketched with emphasis on the pion and proton channels. The counting rate required is evaluated. (J.S.R.)

37070 CHARGED COMPONENT OF 1-GeV ELECTRON SHOWERS IN LEAD. Drickey, D. J. (Stanford Univ., Calif.); Kilner, J. R.; Benaksas, D. Contract Nonr 225(67). Phys. Rev., 171: 310-15(July 10, 1968).

Electron showers from 1-GeV electrons incident on 1–10 radiation lengths of lead were observed in a streamer chamber placed in a magnetic field. The experimental technique was essentially 100% efficient in delineating showers containing either zero or many charged shower particles, permitting a significant increase in accuracy over previous experimental results on shower development. Results are presented for the number of shower electrons present having energies above 5-, 10-, and 25-MeV cutoffs. The data presented have typical errors of about 6% and show good agreement with the results of recent Monte Carlo calculations. (auth)

37071 STUDY OF ELECTROMAGNETIC FORM FACTORS OF THE ELEMENTARY PARTICLES. Kessler, Paul; Bhattacharya, Asit (College de France, Paris). Bol. Univ. Fed. Parana, Fis. Teor. No. 8: 1-20(Dec. 1965). (In French).

A review of the first studies of Hofstadter on the electromagnetic structure of nuclei is given. Several new applications of such techniques are shown: studies of the electroproduction of pi mesons, and of the production of heavy photons are developed, and experiments are proposed for the establishment of form factors for some of the more difficultly examined particles, particularly pi and mu mesons. For the hyperons, one could develop in principle an analysis in terms of Feynman diagrams of the isobaric and peripheral types. The studies for neutral hyperons would require cross sections of the same order of magnitude as those for the pi mesons, and thus information on the electromagnetic form factors for the strange particles might be fairly readily acquired. (BBB)

Weak

37072 (AD–663759) MEASUREMENT OF THE NEUTRAL-K-1-NEUTRAL-K-2 MASS DIFFERENCE. Technical Report, June 1965–October 1967. Carnegie, Robert K. (Princeton Univ., N. J. Elementary Particles Lab.). Oct. 9, 1967. Contract 00014-67-A-0151-0001. 95p. (TR–44). CFSTI.

Thesis.

A new measurement of the magnitude of the neutral-K-1–neutral-K-2 mass difference was completed using the "gap method". The virtue of this method, which consists of monitoring the coherently regenerated neutral-K-1 intensity behind two slabs of material separated by a variable air gap, is its relative freedom from possible systematic errors. The result for the mass difference does not depend on precise knowledge of either the nuclear regeneration amplitude or the details of the detection efficiency of the apparatus. (auth) (USGRDR)

37073 MAGNITUDE AND SIGN OF THE K_1^0 - K_2^0 MASS DIFFERENCE. Murty, Susarla Suryanarayana. San Diego, Calif., Univ. of California, 1967. 154p.

Thesis.

The purpose of this investigation is to study the magnitude and sign of the mass difference $\delta = M_{K_1^0} - M_{K_1^0}$, where K_1^0 and K_2^0 are superpositions of the neutral K^0 and $\bar{K}^0$ mesons. The method used to investigate this consists in producing a K^0 beam, by charge exchange of a K^+ beam, at time zero. The K^0 beam, after a certain time, passes through a stainless steel regenerator. At the exit of the regenerator, the beam contains the originally produced but attenuated K_1^0 beam and a K_2^0 regenerated K_1^0 beam. The phase of these two waves depends on the distance from the source to the regenerator, multiplied by the mass difference, δ. The interference effects of the common decay mode ($\pi^+ \pi^-$) were studied, by varying the distance between the source and the regenerator, and have obtained the following results: proof that the two waves decay into quantum mechanically identical states; the magnitude of the mass difference is $+0.46 \pm 0.02$, and K_2^0 is heavier than K_1^0. (Diss. Abstr.)

Strong (Baryon-Induced)

37074 (DESY–68/17) pp INTERACTIONS AT 10 GeV/c. Almeida, S. P.; Rushbrooke, J. G.; Scharenguivel, J. H.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1968. 72p. Dep.

About 3700 two-prong and 5600 four-prong events of 10 GeV/c pp interactions in the 81-cm hydrogen bubble chamber were measured and analyzed. The reliability of the identification of the different final states was checked using Monte-Carlo generated events. For the channels accessible to analysis cross sections and invariant-mass distributions are given. The cm angular distributions and the mean values of the transverse momentum for all final-state particles are shown and discussed. Production of Δ^{++} (1236) accounts for about 30% of the cross section $\sigma(pp \rightarrow pn\pi^+) = (4.1 \pm 0.4)$ mb. About 50% of the cross section $\sigma(pp \rightarrow pp\pi^+\pi^-) = (2.4 \pm 0.2)$ mb can be accounted for by Δ^{++} production. Production of nucleon isobars at 1450, 1520, and 1730 MeV and their subsequent decay into $p\pi^+\pi^-$ are investigated. Their cross sections, t-dependences and branching ratios are determined, using a one-pion exchange model (OPEM) for calculating the background distributions. The production of resonances decaying into $p\pi^-$ at 1236, 1500, and 1690 MeV is seen, and cross sections are given. Resonance production in the $pp\pi^+\pi^-\pi^0$ and $pn\pi^+\pi^+\pi^-$ reactions are studied using background curves calculated with a model based on simple parameterizations of the cm momentum distributions. The production of nucleon isobars accounts for nearly 100% of these reactions. For the reactions $pp \rightarrow pp\omega$, $pp\eta$, and $pp\eta^0$, the cross sections found are (0.16 ± 0.03), (0.16 ± 0.07), and (0.10 ± 0.04) mb, respectively, corrected for unobserved decay modes. It is shown that most of the gross features of the pion production reactions can be explained by the OPEM with the form factors of Ferrari and Selleri. (auth)

37075 (NP–17500) DATA COMPILATION OF BARYON–BARYON INTERACTIONS. I. PROTON–PROTON COLLISIONS BETWEEN 1 AND 32 GeV/c. Alexander, G.; Benary, O.; Maor, U. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics). [1967]. 45p. Dep.

A review of the properties of proton–proton interactions is presented. A lower limit of 1 GeV/c is placed on the incident proton momentum. Also restriction is made to more basic experimental information, and the rarer type of data such as meson resonance production is omitted. A list of references, curves showing the total and elastic proton–proton cross sections as a function of incident momentum, differential elastic cross sections and polarization curves for various proton incident momenta, and tables for some partial reaction cross sections are given. Data published during the period January 1, 1954, to October 31, 1967 are covered. (J.F.P.)

37076 NUCLEON ISOBAR PRODUCTION IN PROTON–PROTON COLLISIONS BETWEEN 3 AND 7 GeV/c. Ankenbrandt, C. M.; Clark, A. R.; Cork, Bruce; Elioff, T.; Kerth, L. T.; Wenzel, W. A. (Univ. of California, Berkeley). Phys. Rev., 170: 1223-36(June 25, 1968).

A systematic study was made of the reactions $pp \rightarrow pp$ and $pp \rightarrow pN^*$ in the angular range from $\theta_{lab} = 10°$ to $\theta_{c.m.} = 90°$ at 3, 4, 5, 6, and 7 GeV/c. An orthogonal dispersion magnetic spectrometer detected protons from interactions in hydrogen with momentum transfer $(-t)$ in excess of 0.5 $(GeV)^2$. Well-defined peaks in the missing-mass spectra occurred at average N^* masses of 1240 ± 6, 1508 ± 2, and 1683 ± 3 MeV with average full widths of 102 ± 4, 92 ± 3, and 110 ± 4 MeV, respectively. Below 2400 MeV no other significant enhancements were found. The N^* production cross

sections $d\sigma/dt$ near $\theta_{c.m.} = 90°$ are in qualitative agreement with the predictions of the statistical model. For each isobar the differential cross section at fixed energy varies as $\exp(-v/v_0)$, where $v \equiv [-tu/(t+u)]$; v_0 varies systematically with energy and tends toward the same value (≈ 0.4 GeV^2) for each isobar at the upper limit of our energy range. (auth)

37077 ELASTIC SCATTERING OF 660 MeV PROTONS ON LMN CRYSTALS. Cech, J.; Janout, Z.; Lehar, F.; Malek, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods, 63: 83-7(July 15, 1968).

Elastic and quasielastic 660 MeV proton scattering on various targets has been investigated. LMN ($La_2Mg_3(NO_3)_{12} \cdot 24H_2O$) crystal, the equivalent dummy target consisting of $Ba(NO_3)_2$ (36.37%) and MgO (63.63%) and polythene CH_2 were used as targets. The results can be used for the planning of nucleon-nucleon scattering experiments on a proton polarized target. (auth)

37078 CHARGED PION PRODUCTION BY 600 MeV NEUTRON COLLISION WITH NUCLEI OF VARIOUS ELEMENTS. Oganesyan, K. O. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 54: 1273-91(May 1968). (In Russian).

The production of charged pions in collisions between 600 MeV neutrons and Be, C, Al, Cu and Pb nuclei is investigated in a broad angular range by means of a magnetic spectrometer. The spectra of pions of both signs are obtained for the abovementioned nuclei at five angles (16, 30, 60, 90 and 123°). The cross sections, atomic number dependence and angular characteristics of pion production are derived from the spectra. The effect of various factors on the characteristics of pion production is discussed. The analysis yields a qualitative picture of the main laws of pion production. (auth)

Strong (Meson-Induced)

Refer also to abstract 37335.

37079 (ITEF-584) POISKI BARIONNOGO NKπ-REZONANSA SO STRANNOST'YU S = +I V REAKTSII $\pi^-p \to NK\bar{K}\pi$ PRI IMPUL'SE NALETAYUSHCHIKH π^--MEZONOV 3,25 GeV/c. (Investigations of Baryon NKπ Resonance with Strangeness S = +1 in the Reaction $\pi^-p \to NK\bar{K}\pi$ with Momentum of the Bombarding π^- mesons 3.25 GeV/c). Vladimirskii, V. V.; Grigor'ev, V. K.; Grishin, A. P.; Erofeev, I. A.; Il'kov, L. V.; Tikhomirov, G. D.; Trostina, K. A.; Filler, F. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental' noi Fiziki). 1967. 16p. (In Russian). Dep.

The investigation of the final state $NK\bar{K}\pi$ shows a considerable generation of $Y_1^*(1520)$, $Y_1^*(1815)$ and $K^*(892)$ resonances at the incident pion momentum 3.25 BeV/c. Evidence is obtained for the possible existence of the NKπ-resonances with the positive strangeness about 1.8 BeV. (auth)

37080 (LA-3946) EXPERIMENTS WITH MESONS AT ENERGIES BELOW 1 GeV: A BIBLIOGRAPHY. Jackson, Betty S. (comp.) (Los Alamos Scientific Lab., N. Mex.). May 1968. Contract W-7405-eng-36. 195p. Dep. CFSTI.

A bibliography of abstracts on meson interactions at energies below 1 GeV is presented. These abstracts were taken from Nuclear Science Abstracts. Volumes for the years 1959 through 1966 were searched. Though restriction is made to experiments, abstracts of largely theoretical works are included when it is indicated that experiments are performed to validate the theory or when it is not clear from the abstract whether the paper is theoretical or experimental. A permuted index is also given. (J.F.P.)

37081 (UCRL-18254) π^+p 4-PRONG INTERACTIONS BETWEEN 3 AND 4 GeV/c. Brown, David Gordon (California Univ., Berkeley. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 172p. Dep. CFSTI.

Thesis.

The 72-inch hydrogen bubble chamber was exposed to a beam of π^+ mesons at incident momenta ranging from 2.95 to 4.08 GeV/c. The resulting film yielded 39,000 four-prong interactions which were processed using the FSD device and the Fog-Cloudy-Fair data reduction system. Formation of N*(2850) and production of the dominant quasi-two-body final states were investigated. In particular the double resonance channels $N^{*++}\rho^0$, $N^{*++}f^0$, $N^{*++}\omega^0$, and $N^{*++}\eta^0$ were sufficiently free from background to allow consideration of their production mechanisms as seen in their cross sections and angular distributions. One-meson-exchange models were found to account correctly for the general features of the first reaction although being inadequate to explain the fine structure of the experimental distributions. (auth)

37082 MULTIPION PRODUCTION BY π^+ IN HYDROGEN AT 1.48 GeV/c. Ma, Zee-Ming. Durham, N. C., Duke Univ., 1967. 121p.

Thesis.

Multiple pion production by π^+ in hydrogen at 1.48 BeV/c beam momentum was studied using the hydrogen bubble chamber and the Alternating Gradient Synchrotron. The $N_{3,3}^{*++}$ (1236) is produced rather copiously, the tail effect of the $N_{3,3}^{*++}$ ρ^0 which dominates the $\pi^+p\pi^+\pi^-$ final state in experiments of higher momenta is observed. No evidence existed in this experiment for a I = 2 meson resonance. The four prong total cross section is 3.14 ± 0.07 mb. The evidence exists for the $\pi^+p\pi^+\pi^-$ final state undergoing resonance at 1.92 BeV cms energy. The cross section for $N_{3,7}^{*++}$ (1920) $\to \pi^+p\pi^+\pi^-$ is 0.7 ± 0.2 mb from a simple-minded background subtraction method. The production cross sections in this experiment are as follows: 2.14 ± 0.08 mb for $N_{3,3}^{*++}$ $\pi^+\pi^-$, 0.12 ± 0.12 mb for $N_{3,3}^{*++}$ ρ, 0.057 ± 0.025 mb for $N_{3,3}^{*++}$ η where η decays into $\pi^+\pi^-\pi^0$, 0.25 ± 0.04 for $N_{3,3}^{*++}$ $\pi^+\pi^-\pi^0$ and $0.022^{+0.016}_{-0.012}$ for $\pi^+p\eta$ where η decays into $\pi^+\pi^-\pi^0$. In the $N_{3,3}^{*++}$ η production, there is no simple exchange diagram available. The evidence for a baryon exchange in the η production in backward region is presented. (Disser. Abstr.)

37083 SOME TWO-BODY FINAL STATES OF K^-p INTERACTIONS AT 1.33 GeV/c. Trower, W. P.; Ficenec, J. R.; Hulsizer, R. I.; Lathrop, J.; Snyder, J. N.; Swanson, W. P. (Univ. of Illinois, Urbana). Phys. Rev., 170: 1207-22(June 25, 1968).

A study was made of 21,187 two-prong, two-prong-with-kink, and zero-prong-V events at incident kaon momentum of 1.33 GeV/c using the 72-in. hydrogen bubble chamber at the Lawrence Radiation Laboratory and two scanning and measuring projectors in Urbana. The total and partial cross sections were determined for all contributing reactions. For the two-body final states, some production and polarization angular distributions were measured. The angular distributions are discussed in terms of exchanges in the kinematical channels s, t, and u assuming the simplest Feynman graphs. Elastic scattering is analyzed as a diffraction process. (auth)

37084 AZIMUTHAL ASYMMETRY OF THE SECONDARY PARTICLE EMISSION IN A HIGH ENERGY NUCLEAR REACTION. Balcer, E. (Warsaw Univ.); Siemiarczuk, T.; Zielinski, P. Acta Phys. Pol., 33: 619-23(Apr. 1968).

The azimuthal asymmetry in a class of secondaries in the 780 interactions of 9-GeV negative pions with xenon nuclei is observed. The observed asymmetry is correlated with the previously established occurrence of the p-p final state interaction in the secondary particle emission. (auth)

37085 MASS SPECTRUM FOR $\pi^-\pi^-\pi^+$ PRODUCED IN π^-p AT BeV/c. Ascoli, G.; Crawley, H. B.; Kruse, U.; Mortara, D. W.; Schafer, E.; Shapiro, A.; Terreault, B. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 21: 113-16(July 8, 1968).

The negative three-pion mass spectrum between 1.0 and 1.4 BeV was examined in the reactions $\pi^-p \to p(\pi^-\pi^-\pi^+)$, $\pi^-p \to p\pi^0(\pi^-\pi^-\pi^+)$, and $\pi^-p \to n\pi^+(\pi^-\pi^-\pi^+)$ for 5-BeV/c incident π^-. In each reaction peaks are observed near 1.06, 1.17, and 1.30 BeV. (auth)

37086 EXPERIMENTAL EVIDENCE FROM π^+p REACTIONS AT 8 GeV/c AGAINST THE HYPOTHESIS OF PION REGGE CONSPIRACY PLUS FACTORISATION. Aderholz, M. (Technische Hochschule, Aachen); Bartisch, J.; Deutschmann, M.; (and others). Phys. Lett., 27B: 174-6(June 24, 1968).

It has been predicted that with the hypothesis of a Regge trajectory conspiring with the pion trajectory and applying the factorisation theorem, the differential cross section for the reaction $\pi^+p \to N^*\rho^0$ should have a dip in the forward direction near t = 0. It is shown that no such dip is observed in 8 GeV/c π^+p interactions. (auth)

37087 SEARCH FOR S = 2 BOSON RESONANCES IN THE MASS REGION OF 1.0 TO 3.1 GeV. Alexander, G.; Firestone, A.; Goldhaber, G. (Univ. of California, Berkeley). Phys. Lett., 27B: 177-80(June 24, 1968).

Results are presented on a search for S = 2 bosons in the final states K^+K^+ (I = 1), K^0K^+(I = 1, I = 0) and $KK\pi(n \geq 1)$ in a 9 GeV/c K^+p experiment. No statistically significant evidence for such resonances is observed in the mass region 1.0 to 3.1 GeV. The upper limit for the production cross section of the previously reported S = 2 enhancements at 1050 and 1280 MeV is estimated to be 1.5 to 2.0 μb, respectively. (auth)

37088 EVIDENCE FOR THE KINEMATIC ORIGIN OF THE H ENHANCEMENT. Fung, Sun-yiu (Univ. of California, Riverside); Jackson, Warren; Pu, Robert T.; Brown, David; Gidal, George. Phys. Rev. Lett., 21: 47-50(July 1, 1968).

The reaction $\pi^+p \to \pi^+\pi^-\pi^0\Delta^{++}$ was studied in the range 3–4

GeV/c of incident pion momenta. Results suggest that the origin of the H enhancement is purely a kinematic one that arises from the ρ-band cut in an essentially structureless three-pion Dalitz plot. (auth)

37089 OBSERVATION OF A $\rho^-\rho^0$ ENHANCEMENT AT 1710 MeV. Biswas, N. N.; Cason, N. M.; Dzierba, A. R.; Groves, T. H.; Kenney, V. P.; Poirier, J. A.; Shephard, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev. Lett., 21: 50-3(July 1, 1968).

Evidence is obtained for a strong $\rho^-\rho^0$ enhancement from a bubble-chamber study and analysis of 112 events of the type $\pi^- + p \rightarrow p + \rho^- + \rho^0$ at 8 GeV/c. The enhancement is interpreted as a resonance with a mass of 1710 ± 23 MeV and a width of 162 MeV. Branching ratios for different decay modes of the resonance are studied. (L.B.S.)

37090 DOUBLE CHARGE EXCHANGE SCATTERING OF POSITIVE π MESONS ON COMPLEX NUCLEI. Boynton, Paul Edward. Princeton, N. J., Princeton Univ., 1967. 170p.

Thesis.

The differential cross section for the reaction $\pi^+ + N(z,n) \rightarrow \pi^+ + X$ was measured at lab angles 7.5 and 15°, with incident 200 MeV π^+ derived from the external proton beam of the synchrocyclotron. Several target nuclei were employed: ^{51}V, ^{90}Zr, ^{7}Li. The momentum analysis of the final state π^- was accomplished with a magnetic spectrometer using digitized wire spark chambers for track location. Recent theoretical work indicates the possibility of exciting $\Delta_I^+ = 2$ isobaric analog states (for which X = N(z + 2, n − 2) — a two body final state). The data show no evidence of this state, and provide an upper limit of 1 to 2 μb/sr on its excitation at both 7.5 and 15°. The contribution to the cross section from all final states is 40 to 60 μb/sr for the various targets and angles and for 110 < T_π < 200 MeV. The discrepancy between theory and experiment is discussed in terms of a pion-complex nucleus interaction model including effects of higher order inelastic scattering. (Disser. Abstr.)

Particle Interactions and Properties (Theoretical)

General

37091 (AED-C-23-25) HIGH ENERGY PHYSICS INDEX. Volume 6, No. 4 (1703-2462). (Zentralstelle fuer Atomkern-energie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 278p. Dep.

A monthly report of material received at DESY is presented. This material includes experimental and theoretical high-energy physics covering weak, electromagnetic, and strong interactions, strange particles, accelerators, methods and instruments, symmetry principles, and field theory. (J.F.P.)

37092 (AED-C-23-26) HIGH ENERGY PHYSICS INDEX. Volume 6, No. 5 (2463-2848). (Zentralstelle fuer Atomkern-energie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 148p. Dep.

A monthly report of material received at DESY is presented. This material covers experimental and theoretical high-energy physics including strong, electromagnetic, and weak interactions, strange particles, accelerators, methods and instruments, field theory, and symmetry principles. Author and preprint and report number indices are also given. (J.F.P.)

37093 (PUC-937-324) GROUPS, SYMMETRIES, AND QUARKS. PART II. QUARKS. Lipkin, Harry J. (Princeton Univ., N. J. Palmer Physical Lab.). June 1968. Contract AT(30-1)-937. 44p. Dep. CFSTI.

A general description of the present state of the quark model is reviewed. The algebraic structure of the quark model, the group U(6) × U(6) and its subgroups, three point functions in the quark model, and the properties and types of quarks are discussed. (J.F.P.)

37094 RHEONS AS STRUCTURAL COMPONENTS OF ELEMENTARY PARTICLES. Akulov, N. S. Dokl. Akad. Nauk BSSR, 12: 212-18(Mar. 1968). (In Russian).

A method of collective excitation applied to elementary particles was developed. It was shown that the energy of the elementary particles can be considered as a function of the excitation number or photon number as in the theory of the nucleus. A method for the transfer from bosons (phonons) to fermions (rheons), which can be considered as semi-integral quanta, was proposed. All elementary particles are constructed from rheons, in the same way as molecules are constructed from atoms. Formulas were obtained which, except for the integral quantum numbers, contain only the electron mass m_0 and the stable fine structures α. On the basis of these formulas, the masses of $\mu^\pm$, π^0, $K^\pm$, K^0, p, n, N^*, Δ, Δ_8, Σ^0, Ξ, Ω^- were calculated. The maximum derivation from tests is less than 0.2%. The decay schemes and decay energies of the particles were given. Agreement of theory and experiment was obtained. (tr-auth)

37095 SPECTRAL-FUNCTION SUM RULES FOR CURRENTS CARRYING SPIN 2. Iwao, S. (Tokyo Univ. of Education). Nucl. Phys., B6: 71-4(1968).

A spectral representation for the symmetric tensor currents is derived by conjecturing the new PCTC and PCATC hypotheses in addition to the known CVC and PCAC ones. Assuming the equality of the Fourier transforms of the vacuum expectation value of the time-ordered products of two tensor and two axial-tensor currents at infinite momentum we find new sum rules for the spectral functions. (auth)

37096 SPACELIKE SOLUTIONS OF INFINITE-COMPONENT WAVE FUNCTIONS. Chang, Shau-jin; O'Raifeartaigh, L. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 170: 1316-19(June 25, 1968).

A necessary and sufficient condition for the existence of spacelike solutions is given for infinite-component wave equations which are linear in the momentum and for which the charge operator is positive definite. The condition is used to establish the existence of spacelike solutions for wave equations of the Abers-Grodsky-Norton type, i.e., wave equations of the form $(\gamma_\mu p_\mu - M)\psi = 0$, where γ_μ are the Dirac γ's, and M is an SL(2,C) invariant with nontrivial dependence on γ_μ. An interpretation of the spacelike solutions is given for one simple model and suggests that the occurrence of the spacelike solutions in general is simply a reflection of the composite nature of the particles being described. It is also shown that if the current operator has no explicit momentum dependence and the particles are assigned to a representation of SL(2,C), then current conservation is equivalent to a wave equation. (auth)

37097 USE OF THE DYSON REPRESENTATION IN CURRENT-ALGEBRA CALCULATIONS. Perrin, Robert (Harvard Univ., Cambridge, Mass.). Phys. Rev., 170: 1365-6(June 25, 1968).

It is shown, with particular reference to the recent work of Schnitzer and Weinberg, that knowledge of the three-point function of a given set of currents is sufficient to determine certain matrix elements of the equal-time current-density-current-density commutators. (auth)

37098 EXPERIMENTAL RESTRICTIONS IN THE DETERMINATION OF INVARIANT AMPLITUDES. Moravcsik, Michael J. (Univ. of Oregon, Eugene). Contract AT(45-1)-2041. Phys. Rev., 170: 1440-2(June 25, 1968). (RLO-2041-2).

Necessary conditions are proven concerning the type of polarization experiments that must be carried out as part of a set of experiments aimed at uniquely determining the invariant amplitudes of a reaction involving particles of arbitrary spins. (auth)

37099 ASYMPTOTIC BEHAVIOR OF FORM FACTORS AND THE RATIO OF THE RENORMALIZATION CONSTANTS Z_1/Z_3. Acharya, R.; Aly, H. H.; Schilcher, K. (Univ. of Beirut). Phys. Rev., 170: 1597-9(June 25, 1968).

The asymptotic behavior of the form factor of three scalar particles was investigated using the Deser-Gilbert-Sudarshan-Ida-Nakanishi representation. For finite Z_3, it is shown that the form factor tends at most to a constant for large s. The compositeness condition $Z_3 = 0$ implies that $Z_1 = 0$ provided the renormalization function $Z_3(s)$ does not tend to zero faster than $1/s$ for $s \rightarrow \infty$. The relevance of the results to the Lee model and to the Zachariasen model is briefly discussed. (auth)

Electromagnetic

Refer also to abstract 37147.

37100 (IC-68/40) DETERMINATION OF THE PION AND CONSPIRATOR RESIDUES AND TRAJECTORIES IN π^+ PHOTOPRODUCTION FROM CONTINUOUS MOMENT SUM RULES. Di Vecchia, P.; Drago, F.; Ferro Fontan, C.; Odorico, R.; Paciello, M. L. (International Centre for Theoretical Physics, Trieste (Italy)). May 1968. 10p. Dep.

Using continuous moment sum rules clear evidence is obtained for the pion conspiracy. The pion and conspirator residues and trajectories which reproduce with accuracy the forward peak in the high-energy differential cross section are found. (auth)

37101 TEST OF CROSS SECTION SUM RULES FOR NUCLEON MAGNETIC MOMENTS. Lewin, K. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B6: 41-8(1968).

Considering forward Compton scattering by nucleons and deuterons and approximating the deuteron by free nucleons above the pion production threshold the three cross section sum rules

for the nucleon and deuteron magnetic moments are combined to a relation containing only known constants and a low-energy integral which agrees with the predicted value. The result concerning the validity of the sum rules supports other tests based on pion photoproduction data below 1 GeV. (auth)

37102 THEORY OF PHOTOPRODUCTION OF PIONS FROM ^{11}B AND ^{16}O. Griffiths, D.; Kim, C. W. (Johns Hopkins Univ., Baltimore). Nucl. Phys., B6: 49-61(1968).

Gauge invariance and the partially conserved axial-vector current hypothesis are used in the soft-pion approximation for the processes $\gamma + {}^{11}B \rightarrow {}^{11}C + \pi^-$ and $\gamma + {}^{16}O \rightarrow {}^{16}N + \pi^-$, where the final nuclei are in the ground state. The nuclei in the processes are treated as "elementary" particles, the nuclear form factors required being obtained from corresponding beta-decay and electron-scattering experiments. A sum rule is obtained for the total cross sections for the processes $\gamma + {}^{11}B \rightarrow {}^{11}C + \pi^-$ and $\gamma + {}^{11}B \rightarrow {}^{11}Be + \pi^+$, final nuclei being in the ground or excited states. Comparison is made with previous theoretical calculations and experimental results. (auth)

37103 ANOMALOUS NUCLEON MAGNETIC MOMENT SUM RULES WITHOUT CURRENT ALGEBRA. Levers, R. G.; Kamal, A. N. (Univ. of Alberta, Edmonton). Nucl. Phys., B6: 32-40 (1968).

The off-shell gauge violation in the photoproduction of a soft pion or axial spurion is shown to be completely contained in the nucleon pole terms of the amplitude. Using this it can be shown that the partially conserved axial vector current hypothesis, so modified as to take first-order electromagnetic interactions into account, is sufficient to determine sum rules between the anomalous isoscalar and isovector nucleon magnetic moments and the soft-pion forward photoproduction amplitude. Such sum rules were previously obtained using the techniques of current algebra. (auth)

37104 CONSPIRACY OR EVASION; THE ELECTRON'S WAY. Abers, Ernest S. (Univ. of California, Los Angeles); Cassandro, Marzio; Teplitz, Vigdor L.; Muzinich, Ivan J. Contract AT(30-1)-2098. Phys. Rev., 170: 1331-43(June 25, 1968).

The renormalizable perturbation expansion for the scattering of electrons and massive photons is studied as a theorist's experiment, to test conspiracy theory for Regge trajectories. For convenience, all particles are assigned the same mass. It is shown that a nontrivial evasive solution is allowed kinematically, but that the electron trajectory does not choose it. Rather, at least to lowest order, there are three sequences of daughter trajectories, whose values differ by integers at s = 0, and which all conspire in a complicated way with the electron to satisfy the kinematic constraints. This picture is greatly simplified using the O(4) expansion of Freedman and Wang. There are only a small number of Lorentz poles. The problem is reformulated in this language and some of the properties of these poles are discussed. The electron Lorentz pole factors and implies $M = \frac{1}{2}$. (auth)

37105 SPECTRAL-FUNCTION SUM RULES AND MESON MASS SPLITTING. Clavelli, L. (Yale Univ., New Haven); Venturi, G. Contract AT(30-1)-2726. Phys. Rev., 170: 1376-8(June 25, 1968). (YALE-2726-515).

Spectral-function sum rules and the algebra of currents are used to relate symmetry-breaking effects in the pseudoscalar and vector-meson multiplets. (auth)

37106 USE OF POLARIZED PHOTONS AS A PARITY FILTER IN VECTOR-MESON PHOTOPRODUCTION EXPERIMENTS. Cooper, Fred (Harvard Univ., Cambridge, Mass.). Phys. Rev., 170: 1602-3(June 25, 1968).

The implications of doing ρ^0 and ω^0 vector-meson photoproduction experiments with linearly polarized photons are discussed. It is shown, among other things, that the diffractive contribution can be separated from the peripheral contribution by appropriate choice of photon polarization angle. (auth)

37107 ELECTROMAGNETIC MASS DIFFERENCES IN THE SU(6) BARYON BOOTSTRAP MODEL. Koerner, Juergen G. (Columbia Univ., New York). Phys. Rev., 170: 1401-9(June 25, 1968). (NYO-1932(2)-131).

The SU(6) baryon bootstrap model is used to calculate the baryon 56 electromagnetic mass parameters in a first-order expansion in the electromagnetic mass parameters of the constituent 56 baryon and 35 meson multiplets. The direct electromagnetic corrections are approximated by a consideration of the one-photon-exchange constribution. The resulting equations that give the baryonic electromagnetic mass parameters in terms of the mesonic electromagnetic mass parameters and a driving-term contribution have no free parameters. The vector-meson contributions are found to be smaller than the pseudoscalar-meson contributions. Seven electromagnetic mass sum rules that correspond to the vanishing of the 2695 component in the baryonic mass spectrum appear as a consequence of the model. The U-spin approach of SU(3) is adopted to estimate the mesonic electromagnetic mass mixing parameters. The baryonic electromagnetic mass differences that are calculated from these numbers, and the experimental values for the mesonic electromagnetic-mass differences, are in reasonable agreement with experiment. Explicit representations of the reduced matrix elements of the strong and electromagnetic mass operator in the 56 and 35 representations are listed. (auth)

37108 ASYMPTOTIC BEHAVIOR OF FORM FACTORS OF COMPOSITE PARTICLES. Ball, James S. (Univ. of California, Los Angeles); Zachariasen, F. Contract AT(11-1-68). Phys. Rev., 170: 1541-8(June 25, 1968). (CALT-68-146).

Form factors for composite nucleons are studied in the large-momentum-transfer limit. It is argued that multiparticle intermediate states in the dispersion relation, containing arbitrarily large numbers of particles, must be included even to begin to estimate the asymptotic behavior. In the simplest approximation, this physical idea can be implemented using the ladder approximation in the nucleon legs of the form factor. The resulting form factors behave essentially like t^{-2} both for spin-0 and spin-$\frac{1}{2}$ nucleons. (auth)

37109 REGGE-POLE MODEL FOR THE PHOTOPRODUCTION OF VECTOR MESONS. Maheshwari, Amar N. (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 170: 1533-40 (June 25, 1968). (COO-264-418).

A detailed analysis of the vector-dominance model for photoproduction of vector mesons and Compton scattering is presented. It is shown that the vector-dominance model of Compton scattering is consistent with the findings of Abarbanel et al. that a fixed pole is necessary at nonsense value of the angular momentum in the amplitudes for Compton scattering. Good diffraction patterns for the photoproduction of ρ^0 and ω are obtained. It is found from the differential cross section for ω production that the value $x_\omega/x_\rho \approx \frac{1}{3}$, where x_V is the γ-V coupling, is in better agreement with experiment than its estimate from the model of Oakes and Sakurai. Predictions for the angular distribution of photoproduced vector mesons at higher energies ($E_\gamma \approx 18$ GeV) are made. (auth)

37110 UPPER LIMIT FOR THE ELECTRIC DIPOLE MOMENT OF THE NEUTRON. Dress, W. B. (Oak Ridge National Lab., Tenn.); Baird, J. K.; Miller, P. D.; Ramsey, Norman F. Phys. Rev., 170: 1200-6(June 25, 1968). (ORNL-P-3654).

A neutron-beam magnetic-resonance experiment was used to set an upper limit to the neutron electric dipole moment μ_e of $|\mu_e/e| < 3 \times 10^{-22}$ cm, where e is the charge of the proton. A description of the experimental method using very slow neutrons is given, as well as an analysis of the data for systematic effects. (auth)

37111 SUM RULES FOR VIRTUAL COMPTON SCATTERING OF PIONS. Chanda, Rajat; Mohapatra, R. N.; Okubo, S. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Phys. Rev., 170: 1344-52(June 25, 1968). (UR-875-227).

Sum rules for virtual Compton scattering of pions were obtained by using the Weinberg sum rules. Saturation of the sum rules by π, ω, ϕ, A_1, and A_2 intermediate states is found to be still unsatisfactory, suggesting that the sum rules converge very slowly. Also, the connection between the calculation of Das et al. for the π^+-π^0 mass difference and those of the standard techniques is discussed and clarified. (auth)

37112 STRUCTURE AND EXTENSIONS OF A THEORY OF CURRENTS. Bardakci, K. (Univ. of California, Berkeley); Frishman, Y.; Halpern, M. B. Phys. Rev., 170: 1353-9(June 25, 1968).

It is shown that Sugawara's theory of currents can be obtained as a formal limit of the massive Yang–Mills theory. In this limit, $g_0 \rightarrow 0$ and $m_0 \rightarrow 0$ in such a way that $m_0^2/g_0^2 = C$, the constant appearing in Sugawara's theory. The limiting procedure is used to incorporate electromagnetism, the hypothesis of partially conserved axial-vector current and SU(3) breaking into the theory, retaining canonical structure for electromagnetism. (auth)

37113 CONSPIRACY AND EVASION IN π AND K PHOTOPRODUCTION. Henyey, Frank S. (Univ. of Michigan, Ann Arbor). Phys. Rev., 170: 1619-25(June 25, 1968).

An attempt is made to fit π^+ and K^+ photoproduction data near the forward direction by Reggeized π and K exchange, respectively, allowing for possible conspiracies. It is argued that the pion trajectory conspires, with a strength given by the nucleon pole term, while the kaon evades or conspires weakly. It is shown that the unequal-mass kinematics of K photoproduction in no way prevents or restricts the possibility of conspiracy. In the Appendix the choice of kinematics-free amplitudes, including the effect of gauge invariance, is discussed. (auth)

37114 CALCULATION OF γ-3π COUPLING CONSTANT USING CURRENT ALGEBRA. Chatterjee, Aruna (Univ. of Delhi). Phys. Rev., 170: 1578-9(June 25, 1968).

In the framework of the algebra of currents and hypothesis of partially conserved axial-vector current, the γ-3π coupling constant was calculated without using the soft-pion limit. The weak-amplitude term is then calculated in a pole-dominant model, and a sum rule involving the γ-3π coupling constant, the $\rho\pi\gamma$ coupling strength, and the neutral-pion decay lifetime is obtained, allowing the determination of the γ-3π coupling. The result was compared with previous determinations and is in good agreement. (auth)

37115 NUCLEON MAGNETIC MOMENTS IN A BOOTSTRAP MODEL. Barrett, S. M. (Durham Univ., Eng.). Phys. Rev., 170: 1653-9(June 25, 1968).

The bootstrap calculations of baryon magnetic moments by Dashen and Frautschi and by Barton and Dare are examined in an SU_2 model. The pion contribution to the nucleon magnetic moment, which Dashen and Frautschi neglected, is calculated using their method, and is shown to reduce to Barton and Dare's estimate in a nonrelativistic limit. In the SU_2 model, Dashen and Frautschi's method gives for the nucleon isoscalar and vector magnetic moments: $\mu_S = 0$ and $0 < \mu_V < 5.7$ (e/2M), where M is the nucleon mass. (auth)

37116 SOFT-PHOTON THEORY OF NUCLEON–NUCLEON BREMSSTRAHLUNG. Nyman, Ebbe M. (Stanford Univ., Calif.). Phys. Rev., 170: 1628-37(June 25, 1968).

As a consequence of a soft-photon theorem, part of the amplitude for nucleon-nucleon bremsstrahlung depends only on phase parameters measurable in elastic N-N scattering and on the static electromagnetic properties of the nucleon. The corresponding cross section is computed in a fully covariant and gauge-independent fashion, and is found to be in quantitative agreement with most of the existing experimental data. (auth)

37117 VECTOR MESONS IN A CONSTANT EXTERNAL ELECTROMAGNETIC FIELD. Borgardt, A. A.; Karpenko, D. Ya.; Yaroshenko, A. P. (Dnepropetrovsk State Univ., USSR). Yadern. Fiz., 7: 709-10(Mar. 1968). (In Russian).

The wave function describing the v + ps or pv + s mixtures of particles in the reducible representation of Kemmer's algebra was examined, assuming that the electric field stays constant. Degenerate hypergeometric functions were obtained in the derivation. Similar expressions were derived for constant magnetic field and for the projection of the spin onto the direction of the magnetic field, developing expressions for determining energy levels and simplifying the asymptotic equation for weak fields. As a result of the calculations, a simplified expression was obtained for describing the behavior of vector particles in a constant magnetic field on the basis of N. Symond's irreducible representations of the Kemmer algebra. (TTT)

37118 ON THE ANOMALOUS INTERACTIONS, LEPTON STRUCTURE, AND μ–e MASS-DIFFERENCE. Lo, Liau-fu; Yang, Kuoshen; Tan, Lu. K'o Hsueh t'ung Pao, 17: 155-8 (Feb. 28, 1966).

Lepton structure was studied on the basis of anomalous interaction. Because leptons have 3 kinds of interactions (electromagnetic, weak, and anomalous interactions), they should also have 3 kinds of form factors. Leptons having anomalous interaction are designated l and ν. The relations between them can be expressed in three theorems. The structure of the anomalous interaction current of lepton l is identical with its electromagnetic structure. When the mass difference of l and ν is neglected, in the lowest order of perturbation, the form factors of the anomalous interaction current of ν are equal to the electromagnetic form factors of l minus their pure quantum electrodynamical values. When the mass difference of l and ν is neglected, in the lowest order of perturbation, the weak vector structures of l and ν are identical with the structure of anomalous interaction of ν. The muonic moment plays a predominant role in solving the problem of the μ–e mass difference. The muonic moment is formed mainly as the result of an electromagnetic disturbance. Similarly the anomalous magnetic moment of the electron would deviate only very little from the pure quantum electrodynamical value after the disturbance of the anomalous interaction is considered. The self-energy of ν_e is calculated. Because $m_{\nu_e} \leq 5 \times 10^{-4}\ m_e$, m_{ν_μ} should be even smaller than this value. (BBB)

37119 THE $e^-e^+ \rightarrow A\bar{B}$ PROCESS WITH POLARIZED BEAMS. Kessler, Paul (College de France, Paris). Compt. Rend., Ser. A and B, 266: 1089-92(Apr. 22, 1968). (In French).

A general formula for reactions of the type $e^-e^+ \rightarrow A\bar{B}$ was calculated for the case where the electron and the positron are both polarized perpendicularly to the plane of the storage ring. (tr-auth)

37120 STOCHASTIC INSTABILITY OF TRAPPED PARTICLES AND THE CONDITIONS OF APPLICABILITY OF THE QUASI-LINEAR APPROXIMATION. Zaslavskii, G. M.; Filonenko, N. N. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz., 54: 1590-1602(May 1968). (In Russian).

The motion of particles in the field of a plane wave under the action of a perturbation is considered. It is shown that near the separatrix which divides the trapped particles from the untrapped ones, a region (ergodic layer) is formed in which the particle movement is of a stochastic nature. As a consequence, for not very large periods of time the mean energy of the trapped particles increases. The instability described is employed for investigating the motion of particles in the field of a wave packet with a large discrete set of harmonics. Conditions are obtained under which the motion can be described by a Fokker–Planck type of equation (quasilinear equation) under arbitrary initial conditions without any assumptions being made regarding the presence of random parameters in the system. The time of randomization of the particle phase shifts is calculated. (auth)

37121 CONSEQUENCES OF THE MODIFIED PARTIALLY CONSERVED AXIAL-VECTOR CURRENT HYPOTHESIS IN PHOTOPION PRODUCTION. Tapper, Myron Leonard. College Park, Md., Univ. of Maryland, 1967. 96p.

Thesis.

The photopion production process $\gamma + N \rightarrow N + \pi$ is studied in connection with the partially conserved axial-vector current hypothesis which is suitably generalized to deal with electromagnetic interactions. Some interesting relations are derived between the nucleon magnetic moments and certain analytically continued isotopic-spin components of the photo-pion amplitude. It is found that one of these relations contains an amplitude which is related to an electromagnetic transition involving only the isoscalar part of the photon. This amplitude is calculated from the ρ-dominance model in the crossed photoproduction channel $\gamma + \pi \rightarrow N + \bar{N}$. With this model the $\rho - \pi - \gamma$ vertex is calculated in terms of the $\rho - \gamma$ vertex, the renormalized $\pi - N$ coupling constant and the ratio of isoscalar and isovector nucleon magnetic moments. The present analysis gives a numerical value which is considerably smaller than those estimated previously by independent methods. (Disser. Abstr.)

Weak

37122 K_{l3}-DECAY FORM FACTORS, CURRENT ALGEBRA, AND SUBTRACTED DISPERSION RELATIONS. Fuchs, Norman H. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Phys. Rev., 170: 1310-16(June 25, 1968).

The algebra of currents is used in combination with once-subtracted dispersion relations to investigate the form factors $f_+(t)$ which describe K_{l3} decays. The soft-pion approximation is made in the form of a pole-dominance assumption for $q^2 \approx 0$ (q is the pion four-momentum) rather than taking the limit $q \rightarrow 0$. Results are obtained for the scale as well as for the t dependence of the form factors. The calculation is presented in some detail so that the various effects of SU(3) symmetry breaking may be observed. (auth)

37123 CURRENT-ALGEBRA CALCULATION OF THE K_{e5} VECTOR FORM FACTORS. Intemann, Gerald W.; Lapidus, I. Richard (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 170: 1271-8(June 25, 1968).

From considerations of the current-commutation relations of Gell–Mann and the assumption of a partially conserved axial-vector current, the vector form factors for the rare K_{e5} decays are calculated. The presence of K-meson and π-meson pole terms in certain radiative amplitudes is responsible for the complicated momentum dependence of these form factors. The decay rates for the various K_{e5} modes are evaluated, and the results are compared to previous estimates based on various models. (auth)

37124 CHIRAL DYNAMICS OF OCTET BARYONS AND NON-LEPTONIC DECAYS OF HYPERONS. Lee, Benjamin W. (State Univ. of New York, Stony Brook). Phys. Rev., 170: 1359-64 (June 25, 1968).

Chiral dynamics of the octet baryons is discussed, and a phenomenological chiral-invariant Lagrangian is derived. It is noted that in a chiral-invariant Lagrangian for the octet baryons, the structure of the axial-vector currents and the pattern of baryon-meson couplings are uniquely characterized by two free parameters corresponding to G_A/G_V and the D/F ratio of the axial-vector currents. Nonleptonic hyperon decays are discussed from the chiral-dynamics point of view. A discussion is given on the transformation properties of the nonleptonic weak interactions under chiral transformations. Conditions under which the usual current-algebra analyses are valid are elaborated. (auth)

37125 THREE-BODY WEAK PHOTONIC DECAYS OF HYPERONS. Bondyopadhyay, D.; Gupta, K. C. (Univ. of Delhi). Phys. Rev., 170: 1396-8(June 25, 1968).

Three-body weak electromagnetic decays of hyperons are considered within the framework of SU(3) × SU(3) algebra. The decay rates (both parity-conserving and parity-violating) are calculated in the limit of an off-mass-shell pion, in contrast with similar previous calculations done in the soft-pion limit. (auth)

37126 APPLICATION OF CURRENT ALGEBRA AND PARTIALLY CONSERVED AXIAL-VECTOR CURRENT TO THE WEAK BBπ VERTEX. Fischbach, Ephraim (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., 170: 1398-1400(June 25, 1968).

The Sugawara–Suzuki treatment of nonleptonic hyperon decays is extended to include the weak $\Delta S = 0$ parity-violating BBπ vertex, where B is a member of the baryon octet. This vertex gives rise to parity-violating effects in strong and electromagnetic interactions of hypernuclei. It is shown that analogs of the Lee–Sugawara relation may be derived which relate the various $\Delta S = 0$ amplitudes to one another and to the $\Delta S = 1$ S-wave amplitudes. These relations are used to calculate the one-pion-exchange contribution to the parity-violating internucleon potential. (auth)

37127 AN INTERMEDIATE BOSON THEORY. Yang, Kuo-shen; Lo, Liau-fu; Tan, Lu. K'o Hsueh T'ung Pao, 17: 444-6 (May 30, 1966).

A weak interaction theory is based on four postulates. The very important feature of the theory is that in coupling with hadronic currents the intermediate bosons appear as images, but either in the real or in the virtual states they appear as four particles. In the usual theory the projection operator can only be used for the initial or final states, but here ξ is used for intermediate states. Cabibbo's hypothesis on unit length is now explained as the direct result of probability normalization. In previous intermediate boson theories the theoretical values for nonleptonic decay rates are about one order of magnitude lower than that measured. Present calculations show that the baryon pole diagrams, the meson pole diagram, and the $K^* \to \pi$ mechanism are significant in solving this difficulty. Lee's sum rule can be deduced both for parity-conserving and parity-violating amplitudes even when the breaking of symmetry is considered. The baryon pole amplitude exists and does not violate CP conservation. (BBB)

37128 CURRENT-ALGEBRA, SUBTRACTED DISPERSION RELATION, AND K_{l3} FORM FACTORS. Nieh, H. T. (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 21: 116-19(July 8, 1968).

A calculation of the K_{l3} form factors is done on the basis of current algebra, partial conservation of axial-vector currents (strangeness conserving), and dispersion relations. Assuming once-subtracted and unsubtracted dispersion relations for $f_+(q^2) + f_-(q^2)$ and $f_+(q^2) - f_-(q^2)$, respectively, and K^* dominance, the K_{l3} decay parameters ξ, λ_+, and λ_- are calculated. All results are consistent with the present experimental indications. (auth)

37129 DERIVATION OF $F_K/F_\pi = 1$. Acharya, R.; Aly, H. H. (American Univ. of Beirut). Phys. Lett., 27B: 166-7(June 24, 1968).

Assuming the validity of the Dooher, KSFR and the first Weinberg sum rules, the equality of F_K and F_π is established to all orders of SU(3) breaking interaction. (auth)

Strong (General)

Refer also to abstracts 37149 and 37202.

37130 EMPIRICAL MASS RELATIONS FOR THE HADRONIC PARTICLES. Sternheimer, R. M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 170: 1267-71(June 25, 1968). (BNL-12182).

The validity of several types of linear mass relations previously proposed by the author was reexamined in the light of additional experimental information now available concerning the mass spectrum of the hadronic particles. The mass relation $m = pm_\pi$, where p is an integer and $m_\pi = \frac{1}{2}(m_\pi^\pm + m_\pi^0)$, is shown to be satisfied for 13 particles with strangeness $S = 0$. (auth)

37131 SUPERCONVERGENCE RELATIONS FOR ANY SPINS. Krisch, J. P. (Univ of Michigan, Ann Arbor). Phys. Rev., 170: 1648-52(June 25, 1968).

A general superconvergence relation is derived for use with particles of arbitrary spin. It is pointed out that a modified crossing matrix must be defined in the zero momentum transfer limit for some cases. Several examples are exhibited. (auth)

37132 MODEL OF ELASTIC HIGH-ENERGY SCATTERING. Chou, T. T.; Yang, C. N. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., 170: 1591-6(June 25, 1968).

A model for elastic high-energy scattering is presented, using the eikonal picture, or optical model, generalized to the case of two hadrons of finite extension going through each other. Two-dimensional Fourier transforms and a two-dimensional impact parameter b are introduced in the discussion. The relationship with Glauber's theory is analyzed. A comparison with experiment is presented. (auth)

37133 REGGEIZATION OF EXTERNAL PARTICLES. Thiebaux, M. L. (Univ. of Massachusetts, Amherst). Phys. Rev., 170: 1244-54(June 25, 1968).

The possibility of determining the Regge trajectory of an external particle is raised by considering the constraints imposed by bootstrap conditions on the two-body scattering of particles of arbitrary spins and masses. Assuming that the trajectory is the solution of a certain system of equations, it is made plausible that a reduced system corresponding to the continuation in spin and mass of only one external particle can equivalently generate the trajectory if one point on the trajectory is known. The particular system of $\pi\pi$ scattering is taken up as a test case where one external pion has arbitrary mass and spin but otherwise carries the pion internal quantum numbers, and where the bootstrap conditions are based on the self-supporting mechanism of the ρ. Linear combinations of the two independent helicity amplitudes, having kinematic singularities that are uniformly factorizable for arbitrary J, are constructed and unitarized by a phase ND^{-1} method. An implicit solution of the bootstrap matching equations is found, yielding a trajectory which identically passes through the physical pion when $J \to 0$. Only the ratio of the Regge-pole energy-plane residues of the two helicity states is determinable. Finally, a test for uniqueness, largely based on the asymptotic behavior of this ratio as $|J| \to \infty$, is established. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 37167.

37134 ON THE EFFECTS OF SPIN, SYMMETRY, AND POLARIZATION WHEN AN ISOSINGLET RESONANCE DECAYS TO FOUR PIONS. Nelson, Terence John. Iowa City, Iowa, Iowa State Univ., 1967. 62p.

Thesis.

Phase-space distributions for the decay of an isosinglet resonance into four pions are developed. Such resonances have been observed in the final state of the reaction $p + \bar{p} \to 2\pi^+2\pi^- + \pi^0$, for example. Of primary interest are the spin and parity of the resonance. States of four pions that observe Bose statistics and have zero isotopic spin divide into two symmetry types. The distributions are developed phenomenologically from the simplest possible T-matrix for each parity and symmetry type for spins zero and one. In general, eight variables characterize the four-particle decay problem. To facilitate the experimental determination of the spin, parity, and symmetry type, partial integrations of the distributions are performed analytically. The remaining variables are the two two-particle invariant masses of the Goldhaber triangle and angles. One of the angles orients the plane of two of the pions with respect to that of the other two. The distribution in this angle alone provides a significant partial identification of the quantum numbers of the resonance. For spin one, two more angles which specify an external direction have been retained. In the reaction $p + \bar{p} \to 2\pi^+2\pi^- + \pi^0$ the resonance plus pion system was observed to be preferentially aligned with the beam direction. If production takes place equally from the four initial spin states, and if the spin of the resonance is not zero, then conservation of angular momentum along the beam direction results in anisotropy in the decay products. When available, this anisotropy is more sensitive to the spin, parity, and symmetry type than the angle between the planes is by itself. (Disser. Abstr.)

37135 CALCULATION OF THE VECTOR AND AXIAL-VECTOR MESON DECAYS. Lai, C. S. (Indiana Univ., Bloomington). Phys. Rev., 170: 1443-52(June 25, 1968).

The method based on the techniques of current algebra and dispersion relations for calculating the $\rho \to \pi\pi$ and $A_1 \to \rho\pi$ decays is studied further in this paper. It is found that the soft-pion assumption may not be needed in the present approach. The method is then used to calculate the decays of other vector and axial-vector mesons. The decay widths of seven physical processes $\rho \to \pi + \pi$, $K^* \to K + \pi$, $\phi \to \bar{K} + K$, $A_1 \to \rho + \pi$, $K_A \to K^* + \pi$, $K_A \to \rho + \pi$, and $K_A \to \omega + K$ thus obtained are expressed in terms of the known ratio F_K/F_π and four parameters δ, δ_1, δ_2, and δ_3 which are related to the d-wave to s-wave ratios of axial-vector meson decays. In order to fit the experimental data, it is found that the ratio F_K/F_π should be close to 1, and that the param-

eters δ, δ_1, δ_2, and δ_3 may fall into the range of -0.3 to -1.3. With this fit, the agreement with experiment is good. (auth)

37136 DECUPLET SUM RULES FOR PSEUDOSCALAR-MESON–HADRON SCATTERING IN EXACT AND BROKEN SU(3) SYMMETRY. Palmer, W. F. (Argonne National Lab., Ill.). Phys. Rev., 170: 1417-23(June 25, 1968).

It is assumed that an arbitrary s-channel amplitude A + B → C + D superconverges when the t-channel system $A\bar{C}$ belongs to the 10 (or $\overline{10}$) representation of SU(3) or has the quantum numbers $I = \frac{3}{2}$, $Y = \pm 1$ or $I = 0$, $Y = \pm 2$. The particular cases of PP, PV, and PB elastic scattering are studied, both in the SU(3)-symmetric and in the broken-symmetry limit. The PP sum rule is saturated in the SU(3) limit by the nonet spectrum $J^{PC} = 1^{2-}$, 2^{2+}. The Okubo form for the nonet couplings is obtained in the limit of nonet mass degeneracy. When SU(3) symmetry is relaxed, the resultant sum rules provide a constraint on the form (but not the scale) of symmetry-breaking effects. An unphysical result (implying a complex mixing angle) derived by Sakurai from the Weinberg second sum rule and a vector-dominance assumption is reproduced by the vector saturation of a $\bar{K}K$ backward scattering amplitude. It is pointed out that the effects of higher-spin mesons can, in this approach, restore the reality of the mixing angle. Analogous sum rules for PV elastic scattering imply the SU(6) result for the singlet/octet PVV coupling ratio. In the limit of SU(3) symmetry, baryon octet-decouplet mass degeneracy, and zero pseudoscalar-meson mass, the PB sum rule, when combined with the sum rule of Sakita and Wali, yields the SU(6) result for the f/d ratio and the decuplet/octet coupling ratio, independent of experimental input. When SU(3) symmetry is relaxed, the resultant PB sum rules, one of which has been evaluated by Chan and Yen, can provide information on the BBP coupling constants. Typically, the sum rules studied, based initially only on the assumptions of SU(3) symmetry and superconvergence, lead to the results of a higher symmetry when the degenerate mass spectrum of the higher symmetry is used in the saturation scheme. When the mass degeneracy is broken, the sum rules yield information on how this higher symmetry is broken. When SU(3) symmetry is relaxed, the sum rule splits into a family of sum rules which are classified according to t-channel hypercharge and isospin content. Some of these sum rules are still valid provided certain weaker assumptions (such as the conservation, or the absence, of appropriate currents) continue to hold, and these sum rules, in turn, provide information on SU(3) violations. (auth)

37137 CURRENT-DENSITY-CURRENT-DENSITY COMMUTATORS AND VECTOR-MESON DECAYS. Perrin, Robert (Harvard Univ., Cambridge, Mass.). Phys. Rev., 170: 1367-75(June 25, 1968).

The techniques developed in a previous paper for investigating equal-time current-density–current-density commutators by making use of the Dyson representation, and the Ward-identity techniques of Schnitzer and Weinberg are applied to a study of the three-point function relevant to the decays of the ω, φ, and π^0 mesons. It is found that the algebra-of-fields commutation relations do not permit these mesons to decay, and that the pole model of Gell-Mann, Sharp, and Wagner is incorrect, in that the ω-ρ-π vertex is not a constant in the region appropriate to the decays but rather depends linearly on the squared momenta. The commutation relations of U(12) are then assumed, and the Kawarabayashi–Suzuki relation $g_\rho = m_\rho f_\pi$ is obtained as a consistency condition. The unknown constants arising from the equal-time commutators of the π field with the vector currents, and from φ-ω mixing, are fixed by requiring, as a first approximation, the vanishing of the φ-ρ-π vertex, and by feeding the measured value of the width of the decay $\pi^0 \to 2\gamma$. The results then obtained for the widths $\Gamma(\omega \to \pi^0 + \gamma)$ and $\Gamma(\omega \to 3\pi)$ are in excellent agreement with experiment. This agreement is maintained when provision is made to allow for the decays $\varphi \to \rho + \pi$ and $\varphi \to \pi^0 + \gamma$. (auth)

37138 ASYMPTOTIC SYMMETRY AND ϕ DECAY. Clavelli, L. (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., 170: 1378-80(June 25, 1968). (YALE-2726-517).

Isospin violations in ϕ decay are investigated under the assumptions of asymptotic SU(2) symmetry. (auth)

37139 ZEROS IN THE SCATTERING AMPLITUDES OF TWO PSEUDOSCALAR MESONS IN THE NONET STATES. Yabuki, Haruichi (Tokyo Univ.). Phys. Rev., 170: 1410-17(June 25, 1968).

The low-energy pseudoscalar-meson–pseudoscalar-meson scatterings are investigated phenomenologically in terms of the forward dispersion relations. Using the scattering lengths given by the current algebra, it is shown that there exists one general feature common to the scattering amplitudes in the nonet states, namely, that the effective-range functions $(2p/W)\cot\delta$ decrease rather rapidly above threshold. It is suggested that this behavior can be explained by assuming the existence of a zero in the scattering amplitude. Another argument which requires these nonet zeros is given in the framework of the theory of complex angular momenta. (auth)

37140 ANALYTICITY CONSTRAINTS, SINGLE-PARTICLE SATURATION, AND SUPERCONVERGENCE RELATIONS. Rivers, R. J. (Imperial Coll. of Science and Tech., London). Phys. Rev., 170: 1473-7(June 25, 1968).

An examination is made of the constraints upon the mass spectra and coupling constants of intermediate resonant states that are a consequence of requiring that an s-channel single-particle intermediate-state approximation to a scattering amplitude (constructed via a dispersion relation) be analytic in the same domain of positive momentum transfer t (for physical s) as the real amplitude. It is shown that for asymptotically large values of the resonance spin J these constraints are closely related to the mass-spectrum conditions and coupling-constant solutions of superconvergence relations. The cases of $\pi\pi$ and $N\pi$ scattering are considered in detail. (auth)

37141 CURRENT ALGEBRA AND WARD IDENTITIES: THREE- AND FOUR-POINT FUNCTIONS. Gerstein, Ira S. (Massachusetts Inst. of Tech., Cambridge); Schnitzer, Howard J. Contract AT(30-1)-2098. Phys. Rev., 170: 1638-47(June 25, 1968). (MIT-2098-411).

A technique is presented which allows us to display explicitly all the information which current algebra yields about n-point functions of vector and axial-vector currents. All three- and four-point functions are written in terms of a few primitive functions which are not determined by current algebra. Any approximation to these functions (subject to a single constraint) when used in our formulation yields three- and four-point functions guaranteed to satisfy all constraints imposed by current algebra and partially conserved axial-vector current. A very simple model is given where the primitive functions are given by as smooth functions of the momenta as possible and is applied to the π^+-π^0 electromagnetic mass difference, A_1 decay, and π-π and π-ρ scattering. (auth)

37142 CURRENT ALGEBRA, VERTEX FUNCTIONS, AND DECAY WIDTHS OF K^*, Q, AND ϕ MESONS. Gupta, K. C.; Vaishya, J. S. (Univ. of Delhi). Phys. Rev., 170: 1530-2 (June 25, 1968).

Ward identities are set up for three-point functions obeying SU(3) × SU(3) chiral algebra. Assuming single-particle dominance and simple momentum dependence of the vertex functions, decay widths of the K^*, Q, and ϕ mesons are obtained with all the mesons on the mass shell. Further, within this scheme, momentum-dependent K_{l3}-decay form factors are also obtained. Our results are in good agreement with experiments. (auth)

37143 POLARIZATION IN HIGH-ENERGY PROTON–PROTON AND PROTON–ANTIPROTON ELASTIC SCATTERING. Fialkowski, K. (Jagellonian Univ., Krakow). Acta Phys. Pol., 33: 521-8(Apr. 1968).

Polarization in high-energy, fixed momentum transfer elastic pp and $p\bar{p}$ scattering is discussed on the basis of the asymptotic expansion of the scattering amplitudes in terms of the real powers of cm energy. (auth)

37144 ON THE MOTION OF COULOMB POLES IN THE J-PLANE IN QUANTUM ELECTRODYNAMICS. Lipatov, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 54: 1520-9(May 1968). (In Russian).

The asymptotic value of the amplitude for annihilation of a $\mu^+\mu^-$ pair into e^+e^- pair at high energies and fixed nonphysical transferred momenta $Q^2 - (m + \mu)^2 \sim am^2$ is calculated by direct summation of the important contributions of the Feynman diagrams. The asymptotic expression is employed for determining the explicit expressions for the partial waves with complex total angular moments $J \sim \sqrt{a} \ll 1$ in the Q^2-channel. This permits one to investigate the motion of extreme right-hand-side poles in the J-plane. (auth)

37145 S-WAVE $\pi\pi$ SCATTERING LENGTHS FROM SUM RULES AT THE SYMMETRY POINT. Chu, Shu-yuan; Desai, Bipin R. (Univ. of California, Riverside). Contract AT(11-1)-34-P107A. Phys. Rev. Lett., 21: 54-7(July 1, 1968).

A sum rule for the I = 2 amplitude at the symmetry point, $s = t = u = \frac{4}{3}m_\pi^2$, is written down with the assumption that the amplitude satisfies an unsubtracted fixed-energy dispersion relation. This sum rule can be saturated by the S waves and the ρ and f^0 mesons. The known crossing relations at the symmetry point connecting the value and the derivative of the I = 0 amplitude to those of the I = 2 amplitude are then used to show that the I = 0 S-wave scattering length must be small and negative. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 37136, 37140, and 37286.

37146 (INR-P-889/VI/PH) DO WE KNOW HOW TO DISTINGUISH BETWEEN PERIPHERAL AND CENTRAL HIGH-ENERGY MANY-BODY COLLISIONS? Michejda, Lech (Institute of Nuclear Research, Warsaw (Poland)). 1968. 27p. Dep.

The idea of peripheral or central high-energy collisions is expressed in terms of partial inelastic cross sections σ_l corresponding to the initial particles being in the angular momentum state l. Various attempts to determine the total angular momentum J of the many-body states and hence also of the cross sections σ_l via the overlap function are discussed. It is shown that for the 8 GeV/c π^+p interactions neither the uncorrelated jet model nor the multi-Regge-exchange model yield the angular momenta which would satisfy the unitarity condition of the S-matrix, unless the variable phase of the wave function is introduced. From the fact that most of the anisotropy required by the high values of J expected from the data on elastic scattering is hidden in a phase dependence, and from a study of models with variable phase, it is concluded that at the moment it is not possible to solve the question of distinguishing between peripheral and central collisions. (auth)

37147 (NP-17497) DETERMINATION OF PARTICLE SCATTERING AMPLITUDES FROM NUCLEAR PHOTOPRODUCTION. Formanek, J.; Trefil, J. S. (European Organization for Nuclear Research, Geneva (Switzerland)). Sept. 20, 1967. 26p. Dep.

Recent work on the extraction of resonance nucleon scattering amplitudes from the cross section for the production of resonances from helium is extended to include photoproduction and also to include heavier target nuclei. It is found that the reactions $\gamma + {}^4He \rightarrow \rho^0 + {}^4He$ and $\gamma + {}^{16}O \rightarrow \rho^0 + {}^{16}O$ the rho–nucleon scattering amplitude can be deduced, provided that the energy resolution of the experiment is good enough to fix the final state of the nucleus unambiguously. (auth)

37148 SOFT PIONS AND FINITE-ENERGY SUM RULES: APPLICATION TO SCATTERING OF PIONS BY $\frac{1}{2}^+$ BARYONS. Costa, G.; Shaw, G. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys., B6: 1-10(1968).

The well-known soft-pion theorems for pion-baryon scattering are combined with finite-energy sum rules to (a) test the usefulness of given models of the absorptive amplitude, $A + \nu B$; and (b) to gain new information about the Regge exchanges. Assuming Regge terms only at intermediate and high energies (W > 2100 MeV), and resonances at low energies, the πN sum rules predict combinations of Regge parameters in agreement with those from high-energy fits. In $\pi\Sigma$, $\pi\Lambda$ scattering, the following results are obtained independently of the unknown $g\Sigma\Sigma\pi$, $g\Sigma\Lambda\pi$ couplings: that $I_t = 2$ exchange Regge terms must be very small; that the rho trajectory couples approximately universally to Σ; and that if P is an SU(3) singlet, then the P′ must couple to $(\frac{1}{2})^+$ baryons as a mixture of both singlet and octet. The difficulty of saturating the $\pi\Sigma$ Adler-Weisberger relation, unless the sum of couplings $g^2_{\Sigma\Lambda\pi} + g^2_{\Sigma\Sigma\pi}$ is appreciably greater than the values expected from SU(3), is noted. (auth)

37149 AN ABSORPTION MODEL CONSISTENT WITH ELASTIC UNITARITY. Robinson, C. E. (Columbia Univ., N. Y.); Dar, A. Contract AT(30-1)-2098. Nucl. Phys., B6: 62-70(1968). (MIT-2098-398).

An absorption model consistent with elastic unitarity is proposed for two-body and quasi-two-body productions in high-energy hadron collisions. A comparison between the theoretical results and a representative set of experimental results is presented. (auth)

37150 π^- + P ELASTIC SCATTERING AT 1.7 GeV/c. Allen, Donald Dale. Boulder, Colo., Univ. of Colorado, 1967. 75p. Thesis.

The elastic differential scattering cross section from 1.7 GeV/c negative pions on protons is studied in detail. The forward peak is analyzed in terms of a purely optical diffraction mechanism which gives information about the size of the interaction radius. This forward peak also shows an e^{At} dependence where t is the square of the four momentum transferred to the nucleon and A is the slope of the forward peak. From the slope an interaction radius is obtained which agrees within experimental error with that found from the diffraction mechanism. The data exhibit a second maximum at $\cos\theta^*_{\pi^-} = 0.05$ in the barycentric system which corresponds to a four momentum transfer of 1.19 $(BeV/c)^2$. An analysis of the elastic differential scattering cross section is discussed in terms of three models: (1) A purely absorptive model where it is assumed that all partial waves up to L = 4 are absorbed. (2) A modification of the absorptive model to take into account nonabsorptive and spin flip contributions. (3) A model which consists of purely absorptive and spin dependent contributions (which includes a spin flip term). It is found that the purely absorptive model (1) fits the data in the forward peak but is poor at the larger scattering angles. The other two models give much better fits over the entire range of scattering angles. By comparing the two fits from models (2) and (3), the relative importance of the nonabsorptive and spin flip contributions over various angular regions is determined. (Diss. Abstr.)

37151 A NEW METHOD FOR OBTAINING INFORMATION ABOUT THE s-WAVE $\pi\pi$ INTERACTION FROM THE REACTION $\pi^-p \rightarrow \pi^0\pi^0n$. Clegg, A. B. (Univ. of Lancaster, Eng.). Nucl. Phys., B6: 75-83(1968).

It has been found that there are two important mechanisms contributing to the reaction $\pi^-p \rightarrow \pi^0\pi^0n$: production of $N^{*0}(1236) + \pi^0$ which is strongly peripheral, and peripheral production of π^0 pairs which has been ascribed to s-wave $\pi\pi$ scattering. The interference between these two processes is discussed: for suitably selected events this interference can be strong due to a large kinematical overlap. This interference should provide information about the phase of the amplitude for peripheral production of π^0 pairs, which phase is of importance for study of $\pi\pi$ scattering. In particular the effects of this interference are examined in existing measurements of the apparent angular distribution for decay of the N*. It is shown that there is indication of strong interference, of a form which supports the assumption that the peripheral production is a one-pion-exchange process, and that the phase of the s-wave production amplitude is varying slowly with $\pi\pi$ mass. It is suggested that improved measurements of this interference could be used to study the variation of this phase in greater detail, with prospect of deducing better information about s-wave $\pi\pi$ scattering from it. (auth)

37152 STRONG COUPLING OF THE MULTI-PARTIAL-WAVE MESON ISOTRIPLET. Sakita, B. (Univ of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 170: 1453-60 (June 25, 1968). (COO-881-133).

The algebraic formulation of strong coupling is applied to the strong coupling of the SU_3-symmetric model in which all the partial waves of the π mesons are included. The strong-coupling group is a semidirect product of the $SU_2 \otimes SU_2$ internal symmetry group and an Abelian group which is generated by an infinite number of commuting generators corresponding to the vertices of the π mesons in different orbital angular momentum states. A physically interesting irreducible representation of the group is obtained which consists of a series of irreducible representations of the P-wave strong-coupling group. The Regge recurrences of isobars appear in this series. Each degenerate multiplet of isobars is specified by three quantum numbers— spin s, isospin i, and an additional quantum number v— which satisfy the angular momentum triangular relation. The following form of mass formula is obtained: $M(s,i,v) = M_0 + m_0[x(x-1)s(s+1) + (1-x)i(i+1) + xv(v+1)]$. (auth)

37153 MODIFIED TWO-PION-EXCHANGE MODEL FOR DOUBLE-CHARGE-EXCHANGE PROCESSES. Harrington, David R. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., 170: 1460-5(June 25, 1968).

The eikonal method, applied to the problem of coupled channels of different mass in potential theory, is used to derive an expansion for the scattering amplitudes in powers of the potentials between different channels. Just as single-exchange processes are given approximately by the first-order term in the Born series with absorptive modifications, double-exchange processes are given approximately by the modified imaginary part of the second-order term. This result is taken over to a relativistic theory, with one-pion-exchange "potentials" connecting different channels, and used to estimate the differential cross section for the double-charge-exchange process $\pi^- + p \rightarrow \pi^+ + \Delta^-$. (auth)

37154 STUDY OF BOUND-STATE SOLUTIONS TO THE PION–NUCLEON BETHE–SALPETER EQUATION. Rothe, Klaus D. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 170: 1548-68(June 25, 1968). (UCRL-17684).

The Bethe–Salpeter equation describing the interaction of pseudoscalar mesons and nucleons via pseudoscalar coupling is solved numerically for energies below the elastic threshold by use of variational techniques. Only the "ladder" approximation with a local potential corresponding to the exchange of an elementary nucleon is considered. Simple generalizations of this form of the interaction are considered as well. In the absence of a cutoff, this leads to a marginally singular integral equation. The boundary conditions to be imposed on the solutions in order to lead to a discrete eigenvalue spectrum are examined in detail. The study of this problem is considerably simplified at zero

total c.m. energy, where the (Wick-rotated) equation is invariant under four-dimensional rotations. In order to take full advantage of this symmetry, a new set of spinor spherical harmonics belonging to the representations $(\frac{1}{2}(n \pm 1), \frac{1}{2}n)$ and $(\frac{1}{2}n, \frac{1}{2}(n \pm 1))$ of the four-dimensional rotation group is constructed. The discussion is then extended to the general case, in which the formal structure of the $E \neq 0$ solutions is briefly examined. (auth)

37155 PRODUCTION MECHANISMS AND RELATIONS BETWEEN SPIN DENSITY MATRIX ELEMENTS. Ringland, Gordon A.; Thews, Robert L. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 170: 1569-77(June 25, 1968). (UCRL-18010).

The spin structure of amplitudes for the production of a single baryon or meson resonance of arbitrary spin in a quasi-two-body final state was investigated. If the dominant mechanism is the exchange of a single set of quantum numbers in the crossed channel, the spin density matrix elements are shown to satisfy bilinear relations. Typical relations are $(\mathrm{Re}\rho_{m,n})^2 + (\mathrm{Re}\rho_{m,-n})^2 = \rho_{mm}\rho_{nn}$ for baryon production, and $(\mathrm{Re}\rho_{m,n} \pm \mathrm{Re}\rho_{m,-n})^2 = (\rho_{mm} \pm \rho_{m,-m})(\rho_{nn} \pm \rho_{n,-n})$ for meson production. It is suggested that the use of these relations in the analysis of data is a good test for the presence of two or more exchange contributions. The relations are used to analyze vector- and tensor-meson production from πN and KN initial states, and $\Delta(1236)$ production from πN and NN initial states. Two of the most interesting results concern Δ production. It is found that the small-angle data on $NN \to N\Delta$ cannot be dominated by π exchange alone, and analysis of the data on $\pi N \to \pi\Delta$ at 8 GeV/c indicates the existence of contributions in addition to ρ exchange. (auth)

37156 PHASE CONTOURS OF SCATTERING AMPLITUDES. PART I. PHASE CONTOURS, ZEROS, AND HIGH-ENERGY BEHAVIOR. Chiu, Charles B. (CERN, Geneva); Eden, Richard J.; Tan, Chung-I. Contract W-7405-eng-48. Phys. Rev., 170: 1490-1516(June 25, 1968). (UCRL-17899).

Phase contours are defined as curves along which the phase of an invariant scattering amplitude is a constant. These curves are sections of a complex surface, which we take either in the real (s,t) plane or in the complex plane of one of the variables. The relation between phase contours, zeros of the amplitude, and high-energy behavior is discussed. Characteristic features of phase contours are investigated in a variety of special models, and it is seen that basic assumptions about high-energy behavior can readily be expressed in terms of the topology of the phase contours. Specific illustrations of phase contours are given for pion-nucleon scattering based on phase-shift solutions at low and medium energies and on an extrapolation from Regge solutions at high energies. (auth)

37157 $\rho + \rho'$ MODEL OF PION-NUCLEON CHARGE-EXCHANGE SCATTERING AND POLARIZATION. Gajdicar, T. J.; Logan, R. K.; Moffat, J. W. (Univ. of Toronto). (Phys. Rev., 170: 1599-1601(June 25, 1968).

A $\rho + \rho'$ Regge-pole model in which the ρ' is an α-type or nonconspiring trajectory is investigated. It is found to agree with present charge-exchange data and certain superconvergent sum rules. Present polarization measurements are not accurate enough to constrain all the Regge parameters, and a range of solutions emerges consistent with the data. (auth)

37158 FORWARD AND NEAR FORWARD LIMITS IN REGGE POLE THEORY. Sawyer, R. F. (Univ. of California, Santa Barbara); Shepard, H. K. Contract AT(11-1)-34-P107A. Phys. Lett., 27B: 164-5(June 24, 1968).

The regularity of the limit $s \to \infty$, $t \to 0$ is demonstrated for the case of the reaction $\pi N \to \rho N$ with the exchange of an $M = 0$ (A_1) conspiracy. Some general implications for Regge phenomenology are noted. (auth)

37159 THE APPLICATION OF A SUM RULE TO A REGGE MODEL FOR THE HIGH ENERGY πN SYSTEM. Beaupre, James Vincent. Contract W-7405-eng-82. Ames, Iowa, Iowa State Univ., 1967. 71p. (IS-T-171).

Thesis.

Theoretical $\pi^{\pm}p$ total and elastic, and charge exchange differential cross sections, and polarizations, and were fitted to 259 high energy data points, under the assumptions of either a four Regge pole model or a three pole and a cut model. The generalized Restignoli-Sertorio-Toller sum rule, generalized to include the cut, is used to constrain the charge exchange forward amplitude under the assumptions that this amplitude is dominated by either the ρ and ρ' poles or by the ρ pole and a $\rho - P$ cut. The resulting fits, having χ^2's of 438 for the $P + P' + \rho + \rho'$ model and 426 for the $P + P' + \rho + \rho'$ cut model, generally agreed with the data. However, the use of the sum rule strongly depressed the calculated charge exchange polarization for both models. (Disser. Abstr.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 37116 and 37155.

37160 (UCRL-18252) REGGE-POLE FORMALISM FOR PIONIC DISINTEGRATION OF DEUTERON. Lee, Huan (California Univ., Berkeley. Lawrence Radiation Lab.). May 20, 1968. Contract W-7405-eng-48. 50p. Dep. CFSTI.

Thesis.

The reaction $\pi^+ + d \to p + p$ is investigated within the framework of Regge pole theory. Reggeization of the amplitudes for this process is carried out in detail, and the asymptotic behavior of the helicity amplitudes at zero momentum transfer is discussed. By assuming that the lowest anomalous threshold singularity in the t-channel dominates in the nearby region, the nucleon-deuteron Regge residue is calculated in terms of the pion-nucleon Regge residue. Also the relations of various low-energy models used to study this reaction and its inverse to the Regge pole formalism are discussed. (auth)

37161 (UCRL-50426) (p,p) AND (n,p) DATA LISTING 0 TO 750 MeV. MacGregor, Malcolm H.; Arndt, Richard A.; Wright, Robert M. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 15, 1968. Contract W-7405-eng-48. 87p. Dep. CFSTI.

This report gives the computer listings for the (p,p) and (n,p) scattering data (papers VII, VIII, and IX of series on "Determination of the Nucleon-Nucleon Scattering Matrix," the Physical Review). Also included are the references for these data, as used in Table II of papers VII-IX. In a few cases, newer versions of the data were included as described in footnotes. The phase shift analyses included all of the known reliable data as of July 1967. Some updating of these data as of April 1968 is given. (auth)

37162 (UCSD-10-P-10-36) APPLICATION OF FADDEEV EQUATIONS TO PROBLEMS WITH LOCAL POTENTIALS: THE (3α) AND THE (e-H) SYSTEMS. Wong, David Y. (California Univ., La Jolla, San Diego. Dept. of Physics). Apr. 1968. Contract AT-11-1-GEN-10. 23p. (CONF-680429-2). Dep. CFSTI.

From Conference on Three-Particle Scattering in Quantum Mechanics, College Station, Tex.

The Faddeev equations are reduced to a set of coupled one-variable integral equations by using a Sturmian function expansion for the two-body T-matrix with local potentials. It is shown that the ground state and the first excited state of the three-body system can be calculated quite accurately by keeping only a few terms in the Sturmian function expansion. Specific examples considered are: (a) a single attractive Yukawa potential for three identical spinless bosons (b) the (e,e,p) system with pure Coulomb interaction and (c) the (3α) system using a phenomenological potential derived from the α-α scattering data. A perturbative method is suggested for treating the remainder of the Sturmian function expansion. The extension of the present method to the three-body continuum region is also discussed. (auth)

37163 BOUNDS FOR THE CORRECTION TO THE BORN TERM AND APPLICATIONS TO p-p SCATTERING FOR A GENERALIZED DISPERSION MODEL. Binstock, Judith. Berkeley, Calif., Univ. of California, 1967. 41p.

Thesis.

The unitarizing corrections to the Born term, as given by the Chew-Arndt, MacGregor-Arndt (j_0 even), and Scotti-Wong models, are shown to be bounded above and below. The bounds follow from the mathematical forms of the models, to all of which forms a theorem (proved) applies. The correction bounds are given for several p-p amplitudes for the range 0 to 300 MeV. The results are shown to explain why the apparently different models mentioned above give similar Born terms after subtraction of the correction from the experimentally determined (p-p) amplitude. A generalization of these models for the unitarizing correction is proposed, which has properties leading to partial-wave dispersion relations, and which has a specified relation between the asymptotic behavior and the fluctuation of the sign of the left-hand discontinuity. Upper and lower bounds are found for the correction term prescribed by this generalized model (which is not restricted, in its application, to nucleon-nucleon scattering). Also given is a theorem for the full partial-wave amplitude, relating the number of sign changes of the left-hand discontinuity to the amplitude in the physical region. The theorem is applied as a consistency condition to some low partial-wave p-p amplitudes. (Diss. Abstr.)

37164 INTRANUCLEAR CASCADES WITH MANY-PARTICLE INTERACTIONS. Artykov, I. Z.; Barashenkov, V. S.; Eliseev, S. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B6: 11-31(1968).

The Monte-Carlo method is used to consider cascades initiated in various nuclei by mesons and nucleons of an energy from a few

GeV to about 10^3 GeV. It is taken into account that one intranuclear nucleon can interact simultaneously with several particles produced in the foregoing interactions. It is quite necessary to take into account such many-particle interactions in order to explain experimental results in the energy range T > 100 GeV, where almost half of the interactions are of this kind. For T ≈ 10 GeV the fraction of many-particle interactions is also rather great (about 20% in the nuclear emulsion). However, for this energy it affects only weakly the average characteristics of pion–nucleus and nucleon–nucleus interactions. Information on angular and energy distributions of particles produced in many-particle interactions is obtained. Qualitatively these distributions are very similar to the corresponding distributions from inelastic pion–nucleon interactions. The process of evaporation of particles from an excited nucleus formed after the intranuclear cascade is considered. (auth)

37165 SHORT- AND LONG-RANGE CHARGE INDEPENDENCE. Breit, G.; Friedman, K. A.; Holt, J. M.; Seamon, R. E. (Yale Univ., New Haven). Contract AT(30-1)-1807. Phys. Rev., 170: 1424-34(June 25, 1968). (YALE-1807-49).

The difference between the proton-proton (p-p) and neutron-proton (n-p) $^1S_0$ interactions attributable to effects of other than electromagnetic origin is discussed in connection with evidence concerning long-range charge independence. The latter evidence is based on the adjustment of the amplitude of the one-pion-exchange (OPE) group of phase parameters to secure best agreement with p-p and n-p scattering data. It is concerned mainly with distant collisions and long-range effects. The $^1S_0$ phase shift is appreciably influenced by short-range interactions. Although the pion-mass difference is only ≈3.3%, an appreciably larger fractional difference of effective p-p and n-p ranges, $(^1r_0)_{pp} - (^1r_0)_{np}$, is shown to be conceivable. In particular, the approximately 10% effect on $^1r_0$ obtained by Noyes in his effective-range-type analysis, employing a literal acceptance of the published low-energy n-p data, is not out of the question. The argument used for these conclusions is only semiquantitative. It differs from other earlier treatments in that the reconciliation of short-range charge dependence with long-range charge independence is not made to depend on the adjustment of the shape of the energy curve of the N-N potential versus distance at a distance comparable to the core radius, such as results from an adjustable cutoff radius for the OPE interaction. The adjustments in the shape of the potential-energy curve are those needed to reproduce the phenomenological phase-parameter fits to p-p scattering data, with some direct guidance from the data. The semi-quantitative procedure applied to a hard-core potential of the Hamada–Johnston type then yields a fair, though not an exact, reproduction of the phenomenological requirements on the $^1S_0$-(n-p) phase shift in the 0–350 MeV incident laboratory energy range. Although the hard-core-potential work makes a 10% difference in the effective ranges conceivable, it favors a smaller effect, such as $(^1r_0)_{np} = 2.7$°F. The same procedure, when applied to a soft-core potential somewhat similar to that of Reid, does not give nearly as satisfactory a reproduction of n-p data. It appears possible, though far from certain, that the soft-core potential does not give as satisfactory results because it does not include sufficiently the effect of the smeared out δ function of the OPE potential. The procedure used hybridizes the viewpoints of the S matrix and of the equivalent static nonrelativistic potential, with p-p data fitting playing the role of an analog-computer determination of the parameters of the potential. The speculative character of the frequently made assumption of exact equality of the nonelectromagnetic part of the N-N interaction in T = 1 states with L > 0 is emphasized. Evidence regarding the failure of such a view for L = 0 in the 0–350 MeV energy range is reviewed. The desirability of improving existing experimental information on n-p scattering to the point of making it possible to determine both the T = 1 and T = 0 phase parameters for the lower L and J is discussed. (auth)

37166 FITTING OF ELECTROMAGNETIC NUCLEON FORM FACTORS IN A VECTOR-DOMINANCE MODEL. Ng, King-yuen (Columbia Univ., New York). Contract AT(30-1)-1932. Phys. Rev., 170: 1435-40(June 25, 1968). (NYO-1932(2)-133).

By using the Lagrangian theory of vector dominance of Kroll, Lee, and Zumino, a four-parameter fit to the experimental data for the electromagnetic nucleon form factors for spacelike four-momentum transfer squared (q^2) is obtained. The isovector, hypercharge, and baryon-number parts of the nucleon–vector-meson vertices are assumed to have phenomenologically $(1 + q^2/\Lambda_V^2)^{-1}$, $(1 + q^2/\Lambda_Y^2)^{-1}$, and $(1 + q^2/\Lambda_N^2)^{-1}$ momentum dependence. The slope of G_E^{ip} at $q^2 = 0$ is set equal to the Krohn–Ringo value of 0.457 $(\text{BeV}/c)^{-2} \pm 5\%$. The result of the fitting is satisfactory for both large and small q^2. (auth)

37167 ASYMPTOTIC BEHAVIOR IN NUCLEON–NUCLEON SCATTERING. Buttimore, N. H. (Westfield Coll., London). Phys. Rev., 170: 1466-72(June 25, 1968).

A relation between the real part of an elastic scattering amplitude at arbitrary energy and its asymptotic parameters in the Regge model is derived. Together with finite-energy sum rules, this relation is applied to forward nucleon-nucleon and antinucleon-nucleon scattering where the unphysical region is approximated by a number of pole terms arising from the exchange of meson states. A fit to high-energy total-cross-section data and to forward-angle real parts at all energies indicates that there is little dependence on isospin exchanges in the t channel at high energies. When allowed to vary below unity, the intercept of the leading trajectory prefers the maximum value, 1. In this case the nucleon-nucleon total cross sections each tend to 33 ± 1 mb. (auth)

37168 CHARGE INDEPENDENCE IN HIGH-ENERGY SCATTERING FROM DEUTERONS. Wilkin, Colin (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev. Lett., 17: 561-3(Sept. 5, 1966). (BNL-10415).

It is shown that the usual shadow correction for high-energy scattering of particles by deuterons violates charge independence in the case of pions. Alternative formulas are derived which are applicable to this case. (auth)

Particle Invariance Principles and Symmetries

General

37169 (CNAEM-53) LOCALIZATION PROPERTIES OF THE UNITARY REPRESENTATIONS OF THE POINCARE GROUP IN FIELD THEORY. Guersey, Feza (Cekmece Nuclear Research Center, Istanbul (Turkey)). [1966]. 17p. Dep.

Some properties of the unphysical representation of the Poincaré group are discussed. The main result is that the representations with spacelike momentum can be localized in time and two space directions. Explicit localization operators were constructed for this case. These operators are the analogs of the Newton–Wigner position operators. The existence of such operators allows the introduction of harmonic oscillator ladder operators that provide discrete infinite-dimensional representations of the Poincaré group. To use the unphysical representations in field theory where only physical states exist a covariant Heisenberg field operator is separated into parts irreducible under the Poincaré group by taking its matrix elements between two physical states or a physical state and the vacuum. Then the state can be chosen so that the matrix elements are associated with both the physical and the unphysical representations. (J.F.P.)

37170 (CONF-670725) SYMPOSIUM ON THE PRESENT STATUS OF SU(3) FOR PARTICLE COUPLINGS AND REACTIONS, JULY 6–7, 1967. (Argonne National Lab., Ill.). 142p. Dep. CFSTI.

The conference included six papers. Separate abstracts were prepared for all papers. (J.F.P.)

For abstracts of individual papers see: 37171, 37172, 37175, 37177, 37178, and 37185.

37171 (CONF-670725–, pp 4-16) REVIEW OF BASIC SU(3) IDEAS. Harari, Haim (Stanford Linear Accelerator Center, Calif.).

In the review of the basic SU(3) symmetry theory the general concept of an approximate internal symmetry is introduced, and the structure of the SU(3) algebra is discussed. The starting point is a quantum mechanical system characterized by a certain interaction Hamiltonian, it is supposed that there is a set of operators all of which commute with the Hamiltonian. (J.F.P.)

37172 (CONF-670725–, pp 105-42) SU(3) SYMMETRY FOR REGGE RESIDUES. Barger, V. (Wisconsin Univ., Madison).

Experimental tests of the symmetry assumptions of SU(3) for three-particle vertices in the four-particle scattering amplitude are reviewed. The topics covered are the peripheral mechanism, meson exchange, universality and SU(3), symmetry breaking in Regge models, and baryon exchange. It is concluded that there is a very small number of possible SU(3) symmetry applications in dynamical exchange models of the scattering processes. The few accurate tests of SU(3) for vertices of the peripheral exchange mechanism that were thus far made are encouraging. (J.F.P.)

37173 GROUP DYNAMICS OF ELEMENTARY PARTICLES. Kleinert, Hagen Michael. Boulder, Colo., Univ. of Colorado, 1967. 160p.

Thesis.

It is proposed that particle interactions can be described by

means of simple group operations in noncompact Lie groups. Prescriptions for the structure of these group operations are formulated which are motivated by the study of simple models, in particular of the dynamics of the hydrogen atom. If they are fulfilled the structure is called "group dynamics." Neglecting first internal symmetries, a few simple models are investigated on which group dynamics is possible. The group O(3,1) turns out to describe the coupling of pseudoscalar mesons, O(4,2) that of photons to baryons quite well: The pionic decay rates of baryon resonances up to spin $^{19}/_{2}$ and the electromagnetic form factors of the nucleons are predicted in good agreement with experiment. The internal symmetry SU(3) is included in the O(3,1) model of the pionic coupling in the simplest way, by assuming O(3,1) × SU(3) to be the dynamical group. This gives rise to a minimal symmetry breaking of the amplitudes and relates it to the mass differences in SU(3) multiplets: The amplitude consists of a product of a SU(3) Clebsch Gordan coefficient and a universal function of the velocity of the final baryon. The way the particle masses enter the decay rates is uniquely prescribed in this approach. The agreement with experiment is excellent. Finally, connections of this purely algebraic approach with related ideas, like the use of infinite component wave equations, is discussed. (Diss. Abstr.)

37174 THE WEYL COEFFICIENTS FOR THE UNITARY GROUPS U(n). Lezuo, Klaus Jochen. Chapel Hill, N. C., Univ. of North Carolina, 1967. 93p.

Thesis.

The Weyl coefficients are defined as the matrix elements of the Weyl operators in the unitary groups U(n). Knowledge of the Weyl coefficients makes it possible to derive those symmetry relations of the Wigner coefficients which result from the Weyl group. They are of physical interest and constitute a generalization of the "U-spin" techniques, familiar in the calculation of scattering amplitudes in elementary particles physics. It is shown that the problem of calculating the Weyl coefficients can be reduced to finding the matrices which transform the states of the Gelfand basis into the states of the Weyl basis and vice versa. This is the question of finding a realization of the states in terms of the boson calculus. As such, it is a general problem in the theory of the unitary groups, quite independent of the properties of any particular operator. The construction of this boson realization of the states is based on a lemma which exhibits a simple connection for all the states to the state of highest weight in an irreducible representation. The essential tool introduced in this thesis is the "regular line." The regular line is a path defined on the Gelfand pattern which establishes a total ordering of all the parameters in the Gelfand pattern for each numerical occurrence. This concept introduces a significant structure which makes it possible to write down the expansion of the Gelfand basis states in terms of the Weyl basis states directly from the Gelfand pattern. The normalization for this boson realization of the states has been calculated using the known matrix elements of the generators, and is found to factorize according to the subgroup decomposition in the manner of Wigner coefficients. (Diss. Abstr.)

Applications (Electromagnetic and Weak)

37175 (CONF-670725–, pp 56-73) ELECTROMAGNETIC INTERACTIONS AND SU(3). Harari, Haim (Stanford Linear Accelerator Center, Calif.).

The present experimental situation with respect to the SU(3) predictions for electromagnetic decays and photoproduction reactions including pseudoscalar and vector meson production is reviewed. The question of whether the photon is a member of an octet, electromagnetic mass differences, magnetic moments, the decays $\pi \to 2\gamma$, $\eta \to 2\gamma$, radiative decays $A \to B + \gamma$, photoproduction of pseudoscalar mesons, and photoproduction of neutral vector mesons are covered. (J.F.P.)

37176 REMARK ON THE MODEL W = a. Kobsarev, I. Yu.; Okun, L. B. (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Lett., 27B: 172-3(June 24, 1968).

A model W = a, (chimeron model) according to which CP violation is due to a specific CP-noninvariant interaction of the intermediate W boson is considered. It was previously shown that to obtain the smallness 10^{-3} of the $K_L \to 2\pi$ decay amplitude, it was necessary for the constant f of this specific interaction to be of the order of 10^{-3} and not of the order of unity as in the usual a-particle model. It is shown that this estimate of the value of f is not changed even if the total Lagrangian is G_a-invariant. (L.B.S.)

Applications (Strong)

37177 (CONF-670725–, pp 17-38) SU(3) IN MESON DECAYS. Goldberg, Marvin (Syracuse Univ., N. Y.).

The experimental situation concerning SU(3) classifications and decay rate predictions relating to mesons is reviewed. The topics considered are meson classification, the mass formula, experimental data, assumptions in the testing of decay rates, the results of fits to decay rates, and decay rate predictions. (J.F.P.)

37178 (CONF-670725–, pp 39-55) SU(3) AND THE BARYON SPECTRUM. Reeder, D. D. (Wisconsin Univ., Madison).

The hypothesis that SU(3) can be used to systematize the baryon spectrum is discussed. The classification of states with the same spin and parity to representations of the group is reviewed. The experimental test of SU(3) for the strong decays of the baryon resonances is considered. It is concluded from this review that there is little evidence for or against unbroken SU(3) symmetry in baryon decays, but results are at least encouraging. (J.F.P.)

37179 P_{11} π-N SCATTERING AND BROKEN SU(3). Brehm, J. J.; Cook, L. F. (Univ. of Massachusetts, Amherst). Phys. Rev., 170: 1387-95(June 25, 1968).

A dynamical model based on considerations of SU(3) symmetry is presented to explicate the observed behavior of P_{11}, πN scattering. In SU(3)-symmetric P_8-B_8 scattering in the $^{1}/_{2}^{+}$ state, one should expect a $\overline{10}$ resonance as well as an 8 bound state. The possibility that this antidecuplet should be identified with the Roper resonance (1470 MeV) is explored in a broken-symmetry calculation. The model yields values for the nucleon mass, the πN coupling constant, the phase-shift zero, the position and width of the Roper resonance, and the P_{11} scattering length in good agreement with the data. It is argued that this presents a strong case for the view that the Roper resonance is an element of a broken $\overline{10}$ multiplet. (auth)

37180 "BROKEN SU(3)" SYMMETRY IN STRONG-COUPLING THEORY. Sim, Hock-kee; McGlinn, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev., 170: 1582-5(June 25, 1968). (COO-427-77).

The nature of "broken SU(3)" symmetry in the algebraic formulation of strong-coupling theories is investigated. Solutions satisfying the Gell-Mann-Okubo mass formula for some multiplets are exhibited. However, in the case solved, either the spin-$^{1}/_{2}$ octet of the spin-$^{3}/_{2}$ decuplet is not complete. (auth)

37181 SCALE OF MESON AND BARYON COUPLINGS AND UNIVERSALITY IN THE ALGEBRA OF FACTORIZED RESIDUES. Goldberg, H.; Horwitz, L. P.; Ne'eman, Y. (Tel-Aviv Univ., Israel). Phys. Rev., 170: 1320-2(June 25, 1968).

The universality of factorized residues coupled to Regge trajectories in the Cabibbo-Horwitz-Ne'eman algebra scheme yields a scale factor multiplying the SU(3) Clebsch-Gordan coefficient of the F or D type. Two calculation schemes are presented. It is shown, in particular, that the scale factor is unity for the (56,1) baryons and (6,6) mesons of the $[U(6) \times U(6)]_8$ rest classification. (auth)

37182 MASS SPECTRUM AND STRONG DECAYS OF 1^{+} MESONS IN O(4,2) THEORY. Tripathy, K. C. (Syracuse Univ., N. Y.). Phys. Rev., 170: 1626-8(June 25, 1968). (SU-1206-145).

A mass spectrum for mesons with explicit dependence on the tilting parameters was obtained in the dynamical O(4,2) theory. The spin dependence of the masses was assumed. The assignments of n, J^{P}, and isospin of many new meson states are proposed. As an example, the partial (strong) decay rates of mesons $1^{+} \to 1^{-} + 0^{-}$ were computed in good agreement with experiment. (auth)

37183 REGGEIZATION OF U(6) ⊗ U(6). Delbourgo, R. (Imperial Coll. of Science and Tech., London); Salam, Abdus; Rashid, M. A.; Strathdee, J. Phys. Rev., 170: 1477-89(June 25, 1968).

Assuming U(6) ⊗ U(6) invariance of the S matrix in the center-of-mass system, a meromorphy of the physical amplitude in the Casimir plane of U(6) ⊗ U(6) is postulated for a generalized partial-wave analysis. These poles in the S matrix correspond to generalized Regge trajectories, and physically to sequences of U(6) ⊗ U(6) particle multiplets. Detailed specification of different types of trajectories that may arise is examined; these correspond to the ten types of unitary representation of the cross-channel continuation of the rest-symmetry group to GL(6,C) in which up to six Casimir operators are made complex. A particularly simple case is the Reggeization of the quark number which provides the degenerate sequence of U(6) ⊗ U(6) states. For this series the generalized rotation functions are computed. The Reggeization of quark number denudes this number of any fundamental physical meaning; quarks are simply excitation modes. (auth)

37184 SPINOR CURRENTS AND SYMMETRIES OF BARYONS AND MESONS. Miyazawa, Hironari (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 170: 1586-90(June 25, 1968). (COO-264-398).

By introducing spinor currents in addition to the algebra of vector and axial-vector currents, new symmetries of hadrons are obtained in which both baryons and mesons are grouped together in a supermultiplet. These currents are constructed as bilinear combinations of fundamental fields, both bosonic and fermionic. They form a generalized Jordan algebra, whose representations are constructed. As possible models, two examples are given, V(6.3) and V(6.21). In the latter, all known hadrons are included in the adjoint representation. (auth)

Field Theories

General

37185 (CONF-670725–, pp 74-104) EXPERIMENTAL TESTS OF SU(3) REACTION PREDICTIONS. Yodh, G. B. (Maryland Univ., College Park. Arizona Univ., Tucson).

Attempts to compare pure SU(3) predictions with experiment in a model independent manner are described. It is concluded that the predictions for meson–baryon reactions of the type $8 \times 8 \rightarrow 8 \times 8$ are satisfied up to the highest energies for which data are available, that the baryon exchange reactions show violation of SU(3) predictions at low energies when the relations involve Ξ or Ξ^* production, and that it is possible to fit the data on meson–baryon total cross sections the ratio of real to imaginary parts of forward scattering amplitudes and charge exchange processes using five SU(3) invariant amplitudes in the t-channel. (J.F.P.)

37186 PERTURBATION THEORY CALCULATION OF GENERALIZED TWO-POINT FUNCTION IN ELECTRODYNAMICS. Geyer, B.; Robaschik, D. (Karl-Marx-Univ., Leipzig). Acta Phys. Pol., 33: 355-62(Mar. 1968). (In German).

Photon and electron two-point functions were determined in the first nondisappearing perturbation approximation, beginning with the classical field equations of complete electrodynamics, and considering some assumptions on the Wightman functions. The method can be presented so that the two-point functions contain the conventional unrenormalized quantum electrodynamics. (tr-auth)

Quantum Field Theory

Refer also to abstracts 37091 and 37092.

37187 VARIATIONAL CALCULATION FROM INVARIANCE POSTULATE: GENERAL IMPLICATIONS IN MODERN PHYSICAL FIELD THEORY. Rund, H. (Univ., Suid-Afrika, Pretoria). Tydskr. Natuurwetensk., 7: 474-97(Dec. 1967). (In Dutch).

In connection with variational principles as applied to modern physical field theories one has to consider two types of invariance postulates. The first of these determines the transformation properties of the action integral, while the second is concerned with the nature of the dependent functions which are supposed to describe the physical fields under consideration (e.g., scalars, tensors, spinors, or geometric objects in general). These postulates taken in conjunction generally possess surprisingly far-reaching consequences which are expressible in terms of various sets of identities which have to be satisfied by the Lagrangian defining the action integral and its derivatives. One of the basic tools for the derivation of these identities is a new process which gives rise to the construction of the so-called tensor densities with respect to tensorial arguments. The systematic exploitation of such invariance identities yields a great deal of information concerning suitable Lagrangians, the nature of the field, and possible conservation laws, long before the field equations as such are applied. As special cases vector fields (including the electromagnetic field) are discussed; various descriptions of the gravitational field of the general theory of relativity are presented (namely the tensor, the nonmetric, and the tetrad field), with special reference to possible energy–momentum complexes. The general method is also extremely useful when combined fields with distinct transformation properties are considered: this is illustrated by means of a study of combined vector and tensor fields, and as a special application it is shown that the field equations postulated in geometrodynamics can be derived from a single variational principle. Finally, an analysis of spinor fields shows that the method is also applicable to the theory of fermion fields. Most of the results presented are based on long and involved calculations, none of which are given. (auth)

37188 SOME GENERAL PROPERTIES OF PARA-FERMI FIELD THEORY. Ohnuki, Y. (Tokyo Univ.); Kamefuchi, S. Phys. Rev., 170: 1279-93(June 25, 1968).

The nonrelativistic theory of a single para-Fermi field of order p is investigated. General properties of state vectors are studied in detail, and it is shown that the state-vector space can be spanned by the standard state vectors. A restriction on the form of interaction Hamiltonians is derived from the requirement that our formalism be described by local Lagrangian field theory. This restriction on interaction Hamiltonians gives rise to a conservation law of a physical quantity to be called A, which resembles the magnitude of angular momentum with respect to its rule of addition. The conservation law of A leads then to absolute selection rules for reactions, which are a generalization of those obtained elsewhere. The problem of bound states made up of our para-Fermi field is also studied, and all bound states are classified into (p + 1) categories according to their statistical behaviors. It is found that for $p \leq 3$ all bound states can be described by ordinary parafield theory, whereas for $p \geq 4$ such is no longer the case. Furthermore, it can be shown that in the theory of p = 2 no fermion bound states are possible. In this sense it may be said that para-Fermi fields of p = 1 and 3 occupy a very privileged position in para-Fermi theory in general. The main results are stated as 12 theorems. It is expected that the whole argument will be valid in a relativistic theory as well. (auth)

37189 LOGARITHMIC ESTIMATES FROM THE RENORMALIZATION GROUP. Fink, James P. (Univ. of Pittsburgh). Contract AT(30-1)-3829. Phys. Rev., 170: 1580-2(June 25, 1968). (NYO-3829-20).

Renormalization-group arguments are used to discuss the logarithmic asymptotic behavior of the total photon propagator of quantum electrodynamics in any given order. This behavior is also compared with the logarithmic asymptotic behavior of a single-photon self-energy graph of that order. (auth)

37190 FIELD THEORY OF CURRENTS. Sugawara, Hirotaka (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 170: 1659-62(June 25, 1968). (COO-264-404).

A new type of model field theory is constructed. Only currents appear as the coordinates. The canonical formalism is abandoned. The self-consistency, Lorentz covariance, energy-momentum conservation, etc., are checked. (auth)

Gravitation and General Relativity

Refer also to abstracts 36602 and 37187.

37191 (N-68-10738) FURTHER EXAMPLES OF "MACHIAN" EFFECTS OF ROTATING BODIES IN GENERAL RELATIVITY. Cohen, Jeffrey M.; Brill, Dieter R. (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies). Nov. 1967. 18p. (NASA-TM-X-60605). CFSTI.

The exact field equations for the metric of axially symmetric stationary rotating bodies in general relativity are exhibited. They are applied to calculate, to first order in the angular velocity of rotation (but without restriction to weak gravitational fields), the rotation of the inertial frame induced by an incompressible fluid sphere, and by concentric mass shells. In addition, the effect of the exterior field of rotating bodies on light rays is discussed. The results appear to agree qualitatively with some of Mach's ideas on the origin of inertia. (auth)

37192 CONCERNING THE RELATIONSHIP BETWEEN SPACE–TIME DISTANCE AND THE CONSERVATION OF ENERGY–MOMENTUM. Pereira, Carlos Martin. Cleveland, Case Western Reserve Univ., 1967. 86p.

Thesis.

The mathematical structure of Einstein's gravitational field equations is examined. Riquier's existence theorem is applied to these field equations to derive their integrability conditions in the analytic nonvacuum case. The integrability conditions which must be satisfied by the energy-momentum tensor density, are shown to be (a) the vanishing of the anti-symmetric part of this tensor density, and (b) the law of conservation of energy-momentum. The mathematical meaning of the law of conservation of energy-momentum is examined. A distinction is made between the intrinsic properties of the metric tensor (i.e., those properties which are independent of the coordinate system), and the nonintrinsic properties of this tensor (i.e., those properties which depend upon the coordinate system). The covariance of the energy-momentum law is used to demonstrate that if one is given (a) any analytic contravariant energy-momentum tensor density in a given coordinate system x and (b) an analytic specification of the intrinsic properties of the metric tensor, no matter what these properties may be, one can always choose the nonintrinsic properties of the metric tensor in such manner as to satisfy the law of conservation of energy-momentum in the coordinate system x and thereby in every coordinate system. This result is proved only in the case where the contravariant components of the energy–momentum tensor density are given. [A contravariant vector is a vector which transforms like the coordinate differentials dx.] The result does not apply to a covariant or mixed energy-momentum

tensor density. Techniques similar to those already mentioned are used to show that the integrability condition (b) described above actually does not restrict the properties of the contravariant energy-momentum tensor density. It is shown, in fact, that given any analytic symmetric contravariant energy-momentum tensor density, a solution to the gravitational field equations always exists. Furthermore, this solution is such that the law of conservation of energy-momentum is satisfied. Both the geodesic nature of the trajectories of free particles, and the unit magnitude of the velocity 4-vector are discussed. An interpretation of the above described results is given. (Diss. Abstr.)

37193 TESTING RELATIVITY WITH LASER RANGING TO THE MOON. Nordtvedt, K. Jr. (Montana State Univ., Bozeman). Phys. Rev., 170: 1186-7(June 25, 1968).

Precise laser ranging to the moon is shown to be capable of measuring the ratio (m_g/m_i) of gravitational mass to inertial mass of the earth to accuracy sufficient to detect gravitational self-energy contributions. If m_g/m_i of the earth differs from 1 by an amount of order (earth gravitational self-energy)/(earth total energy), then the lunar orbit will acquire a range oscillation of amplitude about 12 m. (auth)

37194 SPINNING SHELL AS A SOURCE OF THE KERR METRIC. De La Cruz, Vicente (Univ. of Alberta, Edmonton); Israel, Werner. Phys. Rev., 170: 1187-92(June 25, 1968).

A method is described which develops the interior field and the physical properties of a slowly spinning, nearly spherical thin mass shell as a power series in the angular velocity ω, on the presumption that the exterior field is the Kerr metric. Results are worked out explicitly, correct to the third order in ω. The ellipticity of the shell is arbitrarily assignable to within quantities of order ω^2. If it is suitably prescribed, the interior field tends to flatness, in the limit where the radius of the shell approaches the gravitational radius, and the extended inertial frames thus defined in the interior are dragged around rigidly by the shell in "Machian" fashion. This amplifies a previous first-order result due to Brill and Cohen. (auth)

37195 HAMILTON–JACOBI VERSION OF GENERAL RELATIVITY. Komar, Arthur (Yeshiva Univ., New York). Phys. Rev., 170: 1195-1200(June 25, 1968).

The invariance group of the general relativistic Hamilton–Jacobi equations is shown to be isomorphic to the group of proper canonical mappings of the solutions of the Einstein field equations. The classical general relativistic Hamilton–Jacobi theory is then elaborated to the point where, via the correspondence principle, the preferred complementary concepts of the quantum theory of gravitation may be identified. The classical considerations indicate that the appropriate complementary concepts to be subject to quantization are the equivalence classes of intrinsic spatial geometries which may coexist in the same space-time manifold and the inequivalent extrinsic space-time stackings of these spatial geometries. (auth)

37196 POSSIBILITY OF THE SPEED OF SOUND EXCEEDING THE SPEED OF LIGHT IN ULTRADENSE MATTER. Bludman, S. A.; Ruderman, M. A. (Imperial Coll. of Science and Tech., London). Phys. Rev., 170: 1176-84(June 25, 1968).

It is shown that, in the classical physics of very dense matter, Lorentz invariance imposes no restriction on the speed of sound or on the ratio of pressure to energy density. Indeed, the simplest and most reasonable classical many-particle theory can manifest such apparently noncausal behavior whenever the calculated self-energy of a particle exceeds its observed (renormalized) rest energy. This comes about because ordinary mass renormalization subtracts out part of a particle's self-interaction energy without altering the interaction with other particles that contributes to pressure. Two types of models are exhibited which, at low densities, show normal behavior and, at high densities, become superluminal (speed of sound greater than speed of light in vacuum) and ultrabaric (pressure greater than energy density). One is a system of classical particles which, when stationary, repel each other by a short-range repulsive Yukawa interaction. Although the particles interact through ordinary retarded neutral vector fields, after mass renormalization there must always be a domain of sufficiently high densities where this matter becomes superluminal and ultrabaric. The second group of models is a class of classical Lorentz-invariant nonlinear field theories which, in the limit of low densities, reduces to a noninteracting Klein–Gordon field. If matter deep inside superdense stars could be ultrabaric, then the limiting gravitational red shift from the star's surface would be slightly under 2. This is perhaps suggestive of the observed clustering of quasar absorption-line red shifts at 1.95. (auth)

37197 GENERAL RELATIVISTIC FLUID SPHERES. I. NEW SOLUTIONS FOR SPHERICALLY SYMMETRIC MATTER DISTRIBUTIONS. Kuchowicz, Br. (Warsaw Univ.). Acta Phys. Pol., 33: 541-63(Apr. 1968).

At present, when general relativity has entered astrophysics not only through cosmology but also through relativistic treatment of stellar structure, it seems appropriate to have on hand an abundance of models describing the internal structure of general relativistic fluid spheres. Till now, only a small number of exact solutions of the Einstein gravitational field equations in space filled with matter is known. Several new solutions are obtained which may be of use in astrophysical research; also a general mathematical scheme of generating new simple solutions is presented. Some of the solutions (which have an especially simple form) are examined and it is found that they may be used at least in certain regions of the fluid sphere; there are, of course, also some solutions being valid everywhere inside the sphere. (auth)

37198 CYLINDRICAL AND NONSTATIONARY GRAVITATIONAL FIELD. Reuss, Jean-Daniel (CEA, Val-de-Marne, France). Compt. Rend., Ser. A and B, 266: 794-6(Apr. 8, 1968). (In French).

A. Papapetrou has obtained a noncylindrical solution more general than the Einstein–Rosen solution. But in order to explain completely the metric, one quantity remains to be determined. This quantity is determined in the present study. (tr-auth)

37199 THEORETICAL NECESSITY OF A POSITIVE VALUE FOR THE BRANS–DICKE COUPLING CONSTANT ω. Noerdlinger, Peter D. (Univ. of Iowa, Iowa City). Phys. Rev., 170: 1175(June 25, 1968).

It is shown a priori that the Brans–Dicke coupling constant ω must be non-negative. (auth)

Scattering Theory

Refer also to abstracts 37133, 37385, and 37396.

37200 (IC–68/31) ON THE ZERO ENERGY BEHAVIOUR OF REGGE POLES AND RESIDUES. Salam, Abdus; Strathdee, J. (International Centre for Theoretical Physics, Trieste (Italy)). May 1968. 61p. (CONF-680519–1). Dep.

From 8th Nobel Symposium on Elementary Particle Theory, Trieste, Italy.

The behavior of partial wave amplitudes in the neighborhood of vanishing momentum is studied in the Born approximation. A set of phenomenological fields is introduced to assist in the construction of a kinematically correct Born term. It is found that the Born contribution to the partial wave amplitudes has a structure which, as a result of the kinematical properties of the phenomenological propagator and vertex parts, yields considerable information about the behavior of Regge poles and residues at zero energy. Regge poles arrived at in this way group themselves into Toller families whose zero energy intercepts, slopes, etc., are severely constrained. Asymptotic formulas for forward scattering amplitudes are obtained. (auth)

37201 (UCRL–18243) PHASE CONTOURS OF SCATTERING AMPLITUDES. Tan, Chung-I (California Univ., Berkeley. Lawrence Radiation Lab.). May 10, 1968. Contract W-7405-eng-48. 76p. Dep. CFSTI.

Thesis.

Phase contours are used to study consistency conditions for a symmetric scattering amplitude having a given high-energy behavior. The latter is taken to correspond to dominance by Regge poles that have continuously rising trajectories. By means of crossing symmetry a sequence of real zeros of the amplitude, that lie along lines of symmetry in the model are introduced $s = u$, in $t < 0$, for example. The leading zero in this sequence is related to the scattering length. Under quite general conditions these zeros may be related, via complex surfaces of zeros, to the zeros of Regge residues below threshold. By considering complex sections of phase contour surfaces, it is shown that these zeros may also be related to a sequence of zeros at complex points, that are due to interference between resonance poles on unphysical sheets above threshold. (auth)

37202 (UCRL–18251) EFFECT OF THE EXISTENCE OF AN ELEMENTARY QUARK ON HIGH-ENERGY SCATTERING. Anderson, Stuart D. (California Univ., Berkeley. Lawrence Radiation Lab.). May 17, 1968. Contract W-7405-eng-48. 43p. Dep. CFSTI.

Thesis.

An elementary quark, if supposed to exist and to couple in quark–antiquark pairs to ordinary two-particle channels, gives rise to a Regge trajectory which would dominate high energy scattering at large momentum transfer. A simple model theory embodying these features is presented. Specifically, the model

assumes a single scalar–scalar pair to represent the ordinary two-particle channel which is observed, coupled to a spinor–spinor channel of large mass, and simple pole-type potentials approximated in the effective range method. The Regge trajectory and subtraction generated by this coupling are computed, and arguments given concerning their contribution to the cross section. Comparison with proton–proton scattering suggests that if such an elementary particle exists, its mass must be greater than about 10 GeV. (auth)

37203 EXISTENCE PROOF BY A FIXED-POINT THEOREM FOR SOLUTIONS OF THE LOW EQUATION. Warnock, Robert L. (Illinois Inst. of Tech., Chicago. Argonne National Lab., Ill.). Phys. Rev., 170: 1323-31(June 25, 1968).

Schauder's fixed-point theorem may be used to show that certain crossing-symmetric S-matrix equations have solutions. The method is illustrated in the case of the one-meson Low equation. It is proved that a sufficient condition for the existence of a solution is that the coupling constant be less than a certain bound which depends on the cutoff and the crossing matrix. The proof works for an arbitrary $n \times n$ crossing matrix with weak conditions on the cutoff function [for instance, $v(k) = O(k^{-2-\epsilon})$, $k \to \infty$]. The allowed range of coupling constants is such as to rule out resonant scattering. A related circumstance is that for the solution in question the baryon is elementary in the sense that it corresponds to a Castillejo–Dalitz–Dyson pole of an appropriate D function. The technique of applying Schauder's theorem differs from that of Atkinson's similar work in that the dispersion relations are approached directly without the aid of the N/D method. Hence the problem of D-function ghosts is avoided, and complete crossing symmetry is ensured. (auth)

37204 STUDY OF THE SINGULARITIES IN THE KOHN VARIATIONAL METHOD FOR SCATTERING PARAMETERS. Brownstein, Kenneth R.; McKinley, William A. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 170: 1255-66 (June 25, 1968).

The Kohn variational method for calculating scattering parameters is formulated in an abstract vector space in terms of the extremization of a quadratic form whose coefficients represent matrix elements of H–E. This manifestly possesses certain symmetry and invariance properties not apparent in the usual formulation. Under certain conditions the method provides a bound for the exact answer if the number of variational parameters, N, is large enough. The extraneous singularities in the variationally determined value of $\tan\delta$ noticed by Schwartz are analyzed. These are a direct consequence of the Kohn method and the particular normalization employed. It is shown that the pole strength (residue) of each such singularity is the product of two terms, each of which is small; these factors may be expected to decrease with increasing N. (auth)

37205 PERTURBATION OF AMADO'S THREE-BODY MODEL. Yaes, Robert J. (Univ. of Helsinki). Phys. Rev., 170: 1236-43 (June 25, 1968).

By using the Faddeev equations, a local, central, perturbing potential and a small mass difference between the particles are introduced into Amado's three-body model. It is shown that to first order in the perturbing potential and in the mass difference, an equation of the same form as Amado's equation will result. The additional terms which appear in the kernel are obtained explicitly. An expression is obtained for the shift in energy of a three-body bound-state pole, in terms of the shift in the kernel. It is shown that the contribution of the perturbing potential to the energy shift is just the expectation value of the potential. (auth)

37206 KHURI–TREIMAN-TYPE EQUATIONS FOR THREE-BODY DECAY AND PRODUCTION PROCESSES. Pasquier, R. (Institut de Physique Nucleaire, Orsay, France); Pasquier, J. Y. Phys. Rev., 170: 1294-1309(June 25, 1968).

Some aspects of a model are discussed for three-body decay (or production) processes based essentially on the elastic approximation in each subenergy channel. A simple method is given to reduce the dispersion integral equations into a single-variable form. In passing, some properties of the triangle-graph amplitude with respect to an internal mass are clarified. Finally the conditions under which the model can nearly satisfy three-body unitarity are discussed; in particular, it is shown that, by simulating high-energy effects in each subenergy variable by a convenient cutoff procedure, three-body unitarity can be satisfied, at least in the decay (or production) region. Only the lowest possible angular momentum states are considered. (L.B.S.)

37207 INELASTIC CONTRIBUTIONS AND D-FUNCTION POLES. Brehm, J. J.; Cook, L. F. (Univ. of Massachusetts, Amherst). Phys. Rev., 170: 1381-6(June 25, 1968).

It is shown that the nonequivalence between the multichannel ND^{-1} method and the one-channel N/D method incorporating inelasticity can be advantageously exploited in a fully dynamical scheme. It is demonstrated that the D-function poles needed for equivalence can be generated out of the inelastic cuts and that the pole parameters may be calculated from models of multichannel scattering. The result is an effective one-channel N/D method, applicable to a class of problems wherein the incorporated inelastic effects are dynamically calculable. (auth)

37208 PHASE CONTOURS OF SCATTERING AMPLITUDES. PART II. CROSSING SYMMETRY, RESONANCE POLES, AND HIGH-ENERGY BEHAVIOR. Eden, R. J.; Tan, Chung-I (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 170: 1516-30(June 25, 1968). (UCRL-17922).

Phase contours are used to study consistency conditions for a symmetric scattering amplitude having a given high-energy behavior. The latter is taken to correspond to dominance by Regge poles that have continuously rising trajectories. By means of crossing symmetry the existence of a sequence of real zeros of the amplitude can be deduced that lie along lines of symmetry in our model, $s = u$, in $t < 0$, for example. The leading zero in this sequence is related to the scattering length. Under quite general conditions these zeros may be related, via complex surfaces of zeros of Regge residues below threshold. By considering complex sections of phase-contour surfaces, it is shown that these zeros may also be related to a sequence of zeros at complex points that are due to interference between resonance poles on unphysical sheets above threshold. (auth)

37209 PARAMETER-INDEPENDENT THRESHOLD CORRECTIONS FOR PARTIAL-WAVE AMPLITUDES FROM LOW-ENERGY SUM RULES. Doebner, H. D.; Mueller, G. W. (Univ., Marburg, Ger.). Phys. Rev., 170: 1604-6(June 25, 1968).

It is shown that the standard N/D equations for partial-wave amplitudes f_l and a set of l centrifugal sum rules are equivalent to one nonsingular integral equation. The solution of this equation automatically satisfies the threshold conditions. The same results hold for any step of an iteration procedure. The inelasticity is included. No additional free parameters appear, in contrast to the usual method for a correction of an N/D solution with a threshold factor. (auth)

37210 THRESHOLD KINEMATIC CONSTRAINTS AND CORRELATIONS OF HELICITY AMPLITUDES. Franklin, Jerrold (Temple Univ., Philadelphia). Phys. Rev., 170: 1606-18(June 25, 1968).

The threshold kinematic constraints and correlations (relations for all helicity amplitudes in terms of one "reduced" helicity-independent amplitude and a given helicity-dependent coefficient) of helicity amplitudes are derived from the threshold behavior of partial-wave amplitudes for any mass and spin combination. Total spin helicity amplitudes are found to be the natural helicity combination for threshold behavior. The pseudothreshold kinematic properties are found to be similar to those at the direct threshold if the total spin helicity amplitudes are modified by appropriate sign changes in their defining linear combinations. The threshold correlations are related to kinematic-singularity-free helicity amplitudes. (auth)

Particle Accelerators

Refer also to abstracts 35998, 36310, 37091, and 37092.

37211 (AD-660658) CAPABILITIES FOR NONNUCLEAR APPLICATIONS WITH NUCLEAR FACILITIES AT NRL. Wolicki, E. A.; Gossett, C. R.; Marlow, K. W.; Toms, M. E. (Naval Research Lab., Washington, D. C.). Oct. 17, 1967. 58p. (NRL-6599). CFSTI.

In order to promote the utilization of nuclear techniques for problems for which they may have an advantage, descriptions are written about the seven major facilities in the NRL Nuclear Physics Division. These facilities are a 75-MeV cyclotron, a 5-MV positive ion Van de Graaff accelerator, a 60-MeV linear electron accelerator (linac), a 2-MV electron Van de Graaff, 1-MW nuclear reactor, a 14-MeV neutron source, and a 13-kCi ^{60}Co irradiation facility. To inform potential users of the range of possible applications, and to facilitate extensions of applications into new areas, a list of the capabilities of these facilities has been compiled. The applications are listed under eleven main categories, according to technique or function. Whenever possible, examples are discussed in terms of the specific non-nuclear areas to which they apply. These examples and the accompanying discussion allow the reader to evaluate the potential benefits of a given technique for his own work. For the benefit of readers not familiar with basic nuclear techniques, additional information has been incorporated in appendixes on the interaction of radiation with matter and radiation

detection, and on more detailed descriptions of each of the major facilities. (auth) (USGRDR)

37212 (BNL-12536) OPTIMIZATION OF ALTERNATING-PERIODIC IRIS-LOADED DEFLECTORS FOR SUPERCONDUCTING RF BEAM SEPARATORS. Hahn, H. (Brookhaven National Lab., Upton, N. Y.). [1967]. 12p. (CONF-680515-3). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Analytical expressions for transverse shunt impedance, peak fields, group velocity, etc., of alternating-periodic iris-loaded deflector cavities operating in the confluent $\pi/2$ mode are derived from the TM_{11}-like small-pitch approximation. It is shown that the smallest peak fields and the largest shunt impedance are obtained in structures with vanishingly small width of the coupling cell. An optimization of the structure determines the ratio of the beam hole radius divided by the wavelength to be 0.3, implying a forward-wave operation. Possible complications due to the degenerate dispersion diagram are discussed. (auth)

37213 (BNL-12539) SOME NEW DETECTOR SYSTEMS. Lindenbaum, S. J. (Brookhaven National Lab., Upton, N. Y.). May 29, 1968. 23p. (CONF-680428-4). Dep. CFSTI.

From Conference on Experimental Meson Spectroscopy, Philadelphia, Pa.

Two hodoscope detector systems used at the BNL AGS for single particle detection and momentum measurement by a magnetic spectrometer system with on-line computer determination of missing mass are described. The first system is a counter hodoscope system whereas the second is a spark chamber hodoscope (wire) system. A new double V (vertex) magnetic spectrometer detector system which is scheduled for assembly and testing in the fall of 1968 is also described. This system will be composed of two multi-particle detecting magnetic spectrometer arms on-line to a computer and will be suitable for detecting and automatically measuring the momentum of the charged decay particles from double vertex events. (B.G.D.)

37214 (BNL-12570) DISCUSSION OF H.V. POWER SUPPLY UNITS CONNECTED WITH HIGH GRADIENT TUBES IN LINAC PREINJECTORS. Kovarik, V. J.; Sluyters, Th. J. M. (Brookhaven National Lab., Upton, N. Y.). [nd]. 21p. (CONF-680515-21). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

In the new accelerating tubes of preinjectors, the gradients (30-50 kV/cm) are significantly larger than in conventional tubes (5-10 kV/cm). The electrons, extracted from the metal surfaces inside the vacuum by electric field emission, increase rapidly with the field strength. A sudden large increase of current, known as a vacuum breakdown or discharge, damages the electrodes, thereby triggering other breakdowns. In the arrangement of high voltage power supplies for high gradient tubes, it is essential to reduce the current in such a discharge. This can be realized by a surge resistor in series with a reduced filter capacitor. However, this influences the beam loading characteristics and consequently the circuit (called the "bouncer") that compensates for it. The selection of the surge resistor in an open 750 kV circuit and its consequences in possible "bouncer" systems are discussed. The characteristics of the 850 kV Haefely Cockcroft-Walton are considered. (auth)

37215 (LA-DC-9415) PROGRAMS FOR COMPUTER CONTROL OF EPA. MacRoberts, M. D. J.; Ohlsen, Sally; Plopper, C. M.; Simmonds, D. D.; Thomas, R. F. (Los Alamos Scientific Lab., N. Mex.). [nd]. 11p. (CONF-680515-13). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Computer programs written to enable an operator to exercise control over the accelerator from the control room via the computer to record data from the accelerator, and to imitate the actions of operators in performing routine procedures such as turn-on sequences are described. This system has been used with the LAMPF electron prototype accelerator for turn-on, turn-off, beam steering, and rf control experiments. This program is aimed toward the development of a computer control system for the LAMPF proton linac. (W.H.K.)

37216 (LA-DC-9419) LINEAR ACCELERATOR FOR UNSTABLE PARTICLES. Nagle, D. E. (Los Alamos Scientific Lab., N. Mex.). [1967]. 7p. (CONF-680515-14). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

The design of a linear accelerator for accelerating unstable particles such as pions is considered. This concept is considered due to high-intensity beams which will become available from meson factories, new accelerating structures, and new techniques such as superconducting cavities. Design parameters for a linac for accelerating pions from 400 to 1200 MeV are presented. (W.H.K.)

37217 (LA-DC-9420) BEAM TRANSPORT DESIGN FOR THE LAMPF INJECTOR. Allison, Paul W.; Stevens, Ralph R. Jr. (Los Alamos Scientific Lab., N. Mex.). [1967]. 11p. (CONF-680515-4). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

The beam transport system from the ion source to the LAMPF linac is described. Design criteria are presented, and lens aberrations of spherical lenses, quadrupole lenses, and bending magnets are discussed. Stability and space charge effects are also considered. (W.H.K.)

37218 (LA-DC-9421) THE LASL HIGH-DUTY-FACTOR ION SOURCE. Emigh, C. R.; Mueller, Donald W. (Los Alamos Scientific Lab., N. Mex.). [1968]. 14p. (CONF-680515-6). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

A description of the design and performance of the duoplasmatron proton ion source for the LAMPF accelerator is presented. The performance of the vacuum system, magnet coils, cooling-water system, ion-source insulating ring, intermediate electrode, and the pulser system is described. Some results of 12 percent duty-factor operation are also presented. (W.H.K.)

37219 (LA-DC-9422) DOUBLE-DRIFT BUNCHER. Emigh, C. Robert (Los Alamos Scientific Lab., N. Mex.). [1967]. 26p. (CONF-680515-7). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

A proposed double-drift buncher for bunching a proton beam for acceptance into a linac is described. The drift space between two rf acceleration gaps and the drift space between the second rf acceleration gap and the linac are utilized to reduce beam loss. Space-chase effects are considered. (W.H.K.)

37220 (LA-DC-9430) MECHANICAL DESIGN OF LASL LINAC STRUCTURES: LAMPF. Worstell, H. G. (Los Alamos Scientific Lab., N. Mex.). [nd]. 19p. (CONF-680515-18). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

The LAMPF linac, which consists of a 201 MHz drift tube linac and an 805 MHz side-coupled system, is described. The mechanical design, vacuum system, and cooling-water system are discussed. (W.H.K.)

37221 (LA-DC-9431) REAL-TIME SAMPLING BEAM POSITION MONITOR. Potter, J. M. (Los Alamos Scientific Lab., N. Mex.). [nd]. 18p. (CONF-680515-15). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

A beam position monitor using the rf structure of the beam is described for use with the LAMPF linac. Theory of operation, sensitivity of beam coupling loop, circuit design, monitor loops, gated mixers, logarithmic if amplifier, de-multiplexer, time base generator, and operational tests are discussed. (W.H.K.)

37222 (LA-DC-9432) DESIGN AND INITIAL PERFORMANCE OF A 20-MeV HIGH-CURRENT SIDE COUPLED CAVITY ELECTRON ACCELERATOR. Knapp, E. A.; Shlaer, W. J. (Los Alamos Scientific Lab., N. Mex.). [1967]. 34p. (CONF-680515-12). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

The 800-MeV LAMPF linac will employ side-coupled standing wave accelerator tanks; therefore, to investigate the properties of side-coupled accelerator tanks the 20-MeV Electron Prototype Accelerator (EPA) was built and tested. The design, principle of operation, and performance of the EPA are presented. (W.H.K.)

37223 (LA-DC-9433) TEMPERATURE CONTROL FOR MAINTAINING RESONANCE OF LINAC TANKS. Swain, G. R.; Gore, R. A.; Jameson, R. A. (Los Alamos Scientific Lab., N. Mex.). [nd]. 10p. (CONF-680515-16). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Development of temperature control systems for resonance control of the LAMPF linac is presented. Most of the controller circuitry is of the analog type. Some of the slower control functions are handled by digital computer control. Parameters for resonance control systems for specific linac types are listed. (W.H.K.)

37224 (LA-DC-9436) LAMPF CONTROL PHILOSOPHY. Gore, Raymond A. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 4p. (CONF-680515-9). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

The basic areas of control are defined, followed by brief descriptions of the various operating systems and a discussion of the basic approach to the computer control of the LAMPF accelerator. Also, results of a computer control of the electron prototype accelerator, planned as a mockup of the LAMPF accelerator, are presented. (W.H.K.)

37225 (LA-DC-9444) 805-MHZ POWER SOURCES FOR THE LAMPF ACCELERATOR. Hagerman, D. C. (Los Alamos Scientific Lab., N. Mex.). [1968]. 10p. (CONF-680515-10). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Triodes, crossed-field amplifiers, and klystrons were tested, and the klystron was chosen to be used as the 805-MHz power source for the LAMPF linac. System specifications and design studies are discussed. (W.H.K.)

37226 (LA-DC-9445) AUTOMATIC CONTROL OF RF AMPLIFIER SYSTEMS. Jameson, R. A. (Los Alamos Scientific Lab., N. Mex.). [1968]. 10p. (CONF-680515-11). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Development of the rf control system for the LAMPF linac is discussed. Prototype versions of all hardware are operating in the electron prototype accelerator system and have been used for testing the design approach. Measurements are being made to investigate system interactions, nonlinearities, and second-order effects as the basis for final design. (W.H.K.)

37227 (LA-DC-9446) FAULT PROTECTION CIRCUITRY FOR THE LASL 201.25-MHz POWER AMPLIFIERS. Doss, J. D. (Los Alamos Scientific Lab., N. Mex.). [nd]. 8p. (CONF-680515-5). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Circuits are presented to protect the rf power amplifiers for the linear accelerator from such faults as high anode currents and rf arcs. The anode-current detector consists of a Schmitt-trigger type circuit that generates an output to inhibit the pulse gate whenever anode current exceeds 25 percent of its normal maximum load. A modulator grid-clamp circuit is used to solve the problem of negative grid current. Crowbar circuitry is used to protect against arcing, amplitude faults, and pulse width faults. (W.H.K.)

37228 (LA-DC-9451) HIGH-DUTY FACTOR MODULATOR FOR LOS ALAMOS MESON PHYSICS FACILITY. VanVessem, T. G. (Los Alamos Scientific Lab., N. Mex.). [nd]. 3p. (CONF-680515-17). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

The Los Alamos Meson Physics Facility (LAMPF) requires 3 MW of peak rf power from each of three 200-MHz sources. Each source requires a series anode modulator which has three principal functions, viz, programming the amplifier pulse length and rate, varying the amplifier plate voltage during the pulse so as to provide an rf power output controllable over a dynamic range of 30% to a tolerance of ±3%, and switching the amplifier off quickly in the event of a load fault. The modulator must be capable of operation initially at 8.4% DF (700 μsec, 120 Hz) with a design capability of 14.4% DF (1200 μsec, 120 Hz). A modulator utilizing either two Machlett 7482-PV triodes or two ITT 7560 triodes which has been constructed and tested for this purpose is described. (auth)

37229 (LA-DC-9452) LAMPF 200-MHz POWER SOURCES. Faulkner, J. R.; Boyd, T. J. Jr. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 5p. (CONF-680515-8). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

The Alvarez section of the proton linear accelerator for the Los Alamos Meson Physics Facility will require three 3 MW and one 300 kW, 200-MHz rf power sources. The power delivered to the accelerator tanks must be controlled over a dynamic range of approximately 30% while maintaining a field amplitude tolerance of ~±1.5% with a phase tolerance of ~±2°. The minimum rf duty factor (DF) requirement is 8.4% (for a 6% DF beam) with a design capability of 14.4% (12% beam). The moderate peak but high average power requirements have had a considerable impact on the design and engineering of the rf amplifier cavities and their peripheral circuitry. A description of the system is presented, and problems encountered in the design are discussed. (auth)

37230 (LA-DC-9478) 80-KILOVOLT BLOCKING OSCILLATOR MODULATOR. Doss, J. D.; Cady, R. L.; Hagerman, D. C.; Turner, T. F. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 12p. (CONF-680520-1). Dep. CFSTI.

From 10th Modulator Symposium, New York.

The Los Alamos Meson Physics Facility will use approximately 44 klystrons in the 805-MHz waveguide section of the linac. Pulse width and repetition rate will be 1 msec and 120 Hz respectively. Each klystron will be capable of delivering 1.25-MW peak power output at 12% DF. These klystrons are equipped with a modulating anode that must be switched from cathode potential to approximately body potential to turn the beam on. The peak voltage swing required from the modulator is about 80 kV with a load current of a few milliamperes to the modulating anode and 1.0 ampere to a parallel resistive load. The switch tube used for this modulator is a Machlett ML-7248 tetrode. The blocking-oscillator regenerative modulator is examined in detail. (B.G.D.)

37231 (N-68-16785) UNIFORMITY OF PROTON BEAMS AVAILABLE AT THE NASA SYNCHROCYCLOTRON (SREL). Hill, Gerald F.; Honaker, William C.; Kim, K. H. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). 1967. 17p. (NASA-TM-X-60860). CFSTI.

Space radiation simulation is achieved by degrading either of the two primary extracted proton beams having measured energies of 595 and 325 MeV. The primary extracted beams are degraded to lower energies by using copper absorbers located in the magnet hall of the facility. Proton beams having energies from 595 to approximately 30 MeV can be obtained at the target position. Both small and large area beams are available over a wide energy range. The final-beam configuration at the target position, however, is dependent upon the optimization of some 25 magnets located in the proton beam transport system (P.B.T.S.). Because of this, an extensive proton beam characterization study was initiated and recently completed. This paper summarizes the characteristics of approximately 30 beam configurations and includes such parameters as proton beam energy, energy spread, intensity, intensity profile, repeatability, and area. The results reported here are primarily related to large area beams which are of interest to experimenters studying the radiation effects of protons on animals. Uniformity of several large area beams is discussed in terms of dose rate (rads/min) in muscle. (auth) (STAR)

37232 (ORNL-tr-1916) AN APPROXIMATE METHOD FOR CALCULATING A SHIELD FOR THE SCATTERED RADIATION OF ACCELERATORS. Zaitsev, L. N.; Kimel', L. R.; Komochkov, M. M.; Sidorin, V. P.; Sychev, B. S.; Ulitin, O. A. Translated for Oak Ridge National Lab., Tenn., from report JINR-P16-3591. 20p. Dep. CFSTI.

This report was previously included in NSA and appears as 22: 9718. (W.H.K.)

37233 (PPAD-646D) PROPOSED HIGH CURRENT BOOSTER SYNCHROTRON FOR THE PRINCETON-PENNSYLVANIA ACCELERATOR. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). June 21, 1968. Contract AT(30-1)-2137. 96p. Dep. CFSTI.

This is a proposal to the Atomic Energy Commission to finance the construction of a new particle injector for the Princeton-Pennsylvania Accelerator which would increase the proton current by a factor of 20 above present levels and which would also be capable of injecting all other particles of interest. While our presently planned future research program is centered around protons and deuterons of the highest attainable intensity, we are also eager to accelerate these ions as polarized particles. The same basic injector can be equipped at a later date, and at a modest cost, with facilities for injecting heavy ions in a high charge state to many billions of electron volts. The effect of raising the proton current by a substantial factor would be to make available for study a large category of fundamental particle experiments which now are marginal or simply impracticable. Having polarized protons and deuterons available would open up areas for experimentation on fundamental particles which now are simply out of the question. Finally, the acceleration of heavy ions to multibillion volt energies would be very interesting to scientists studying nuclear structure, solid state physics and also to those interested in the bio-medical aspects of high energy, highly charged ions. While the primary motivation for this proposal is the scientific need for a substantial increase in proton current, we wish to emphasize that the injector design chosen is not only the best and cheapest for this purpose but also lends itself in an almost ideal manner to the injection of all ions of an arbitrary charge to mass ratio. The estimated cost of the injector is $3,394,000, if equipped only for proton or deuteron injection, with an increase of $450,000 being required for the addition of polarized particles and a further $580,000 for heavy ions. Construction could be completed within two years after construction

funds are made available provided we do some preliminary prototype testing. (auth)

37234 (SLAC-PUB-420) RECENT DEVELOPMENTS AT SLAC. Helm, R. H.; Loew, G. A.; Miller, R. H.; Neal, R. B. (Stanford Linear Accelerator Center, Calif.). May 1968. 29p. (CONF-680515-19). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Some of the recent results obtained at SLAC in conjunction with the operation of the two-mile accelerator are presented. Various key improvement programs now under way or projected in the near future are described. (auth)

37235 (UCRL-18228) BEVATRON OPERATION AND DEVELOPMENT. 56. October-December 1967. Crebbin, Kenneth C.; Frias, Robert (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1, 1968. Contract W-7405-eng-48. 10p. Dep. CFSTI.

The beam was on for 90.6% of the scheduled operating time. The beam was off 4.6% of the scheduled operating time because of equipment failure and 4.8% of the scheduled operating time for experimental setup, tuning, and routine checks. During the quarter, the Bevatron accelerated 1.45×10^{18} protons. Fractures were detected in the dovetail area of the main motor generator poles. Monitoring and inspection procedures have been established. (auth)

37236 (UCRL-18246) IMPROVEMENTS TO THE BERKELEY HILAC. Haughian, James M. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 14p. (CONF-680515-22). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

It is proposed to lengthen the HILAC prestripper cavity to 20 feet, operate at a maximum electric gradient of 640 kV/ft, and utilize magnetic quadrupole drift tube focusing. This system will be capable of accepting ions with charge-to-mass ratios as low as 0.095, thereby taking advantage of increased source output at lower e/m ratios and providing greater transmittance through the cavity. The proposed system is expected to produce a krypton beam approximately 500 times more intense than considered possible with the existing system. (auth)

37237 ZERO RESISTANCE. Long, Hugh (Union Carbide Corp., Indianapolis, Ind.). Ind. Res., 10: 60-5(Mar. 1968).

Applications of superconductivity, particularly in a large bubble-chamber magnet at Brookhaven National Lab and in the Stanford linear electron accelerator, are reviewed. In the 3.6-m Argonne bubble chamber now under construction, the superconducting design will save from 350,000 to $400,000 per year in operating costs. The Brookhaven 4.9-m bubble chamber magnet now under consideration is a split-coil system with no iron return path. It will require higher performance from the superconducting material but should result in power savings of over $1.5-million per year, compared to conventional copper coils. The superconducting, linear electron-accelerator for the Stanford High Energy Physics Laboratory will be 150 m long and produce a continuous beam at 7.5 GeV. The 150-m apparatus will have microwave cavities made of superconducting lead or niobium. To achieve low losses, the accelerator will operate at 1.85°K. The 7.5-GeV instrument also will benefit from the high thermal conductivity of superfluid liquid helium (1300 times greater than copper), which will keep the temperature differential along the accelerator at the desired small value. (BBB)

37238 THE PRODUCTION OF FAST NEUTRONS BY ^{3}He INDUCED NUCLEAR REACTIONS. Bruninx, E.; Crombeen, J. (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). pp 247-60 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18-19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

The energy spectrum of the fast neutrons produced in the forward direction by 20-MeV ^{3}He particles on a beryllium target was measured using nuclear reactions with different reaction thresholds. The results were interpreted by means of an empirical formula. At the same time the angular distribution of the fast neutrons was determined and the total yield/microcoulomb estimated. (auth)

37239 PROCEEDINGS OF THE 3rd CONFERENCE ON ACCELERATOR TARGETS DESIGNED FOR THE PRODUCTION OF NEUTRONS, LIEGE (BELGIUM), SEPTEMBER 18-19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. 323p. $10.00. (In several languages). (EUR-3895; CONF-670960).

Separate abstracts are prepared for the 20 papers presented. (W.H.K.)

For abstracts of individual papers see: 36037, 37238, and 37240-37257.

37240 LATEST DEVELOPMENTS IN THE PREPARATION OF TRITIATED TARGETS AT LIEGE UNIVERSITY. Peters, J. M. (Univ., Liege). pp 41-59 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18-19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3895; CONF-670960.

Since the last Grenoble Conference, research on tritiated targets has been concerned firstly with the study and adaption as a tritium target of an organic polymer of high specific activity, synthesized from gaseous tritium in the most favorable conditions. The autoradiolysis of the tritiated compound is limited to an extremely low level. The calculated lifetime is 10^5 hours. Secondly, research has been conducted into the optimum conditions for the fabrication of tritiated titanium targets. Various metallization and impregnation techniques have been tested and compared. The neutron yields obtained reach equivalent values for tritium contents lower than those of commercial targets. The half-lives are attained for a total cumulated charge of 3.2 to 3.4 Coulomb. (auth)

37241 THE FABRICATION OF TRITIATED TARGETS AT SACLAY. Manin, A.; Cholet, D. (CEN, Saclay, France). pp 31-40 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18-19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3895; CONF-670960.

Tritium targets are prepared at Saclay by a conventional method consisting of two well-separated stages, namely, the volatilization of titanium and the impregnation of the thin layer. A description is then given of the main controls of our machines, their empirical nature being stressed. Controls are never transposed from one apparatus to another without correction. Lastly, the maximum titanium thickness and tritium charge attainable are given. Brief reference is made to the main faults which may occur on the targets. (auth)

37242 METHOD OF DETERMINING THE SPATIAL DISTRIBUTION OF TRITIUM IN THIN-BACKED TARGETS. Fort, E.; Huet, J. L. (CEN, Cadarache, France). pp 21-30 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18-19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3895; CONF-670960.

The method consists essentially of determining the energy spectrum of charged ^{3}He particles associated with neutrons in the $T(p,n)^3He$ reaction. The ^{3}He particles produced at a fixed angle, ten degrees towards the front, by a proton beam of constant energy are separated by an electromagnetic analyzer from the particles coming from parasite reactions. They are detected by a surface-barrier gold-silicon detector. By knowing the range-energy curves for the ^{3}He particles, deduced from the range-energy curves for the protons in the target material, it is possible to arrive at the tritium distribution in the target from the energy spectrum of the ^{3}He particles. The accuracy of the measurements depends primarily upon that of the range-energy curves for the ^{3}He particles and upon the resolution of the analyzer. (auth)

37243 LIFE OF TRITIUM TARGETS UNDER DEUTERON BOMBARDMENT. Smith, D. L. E. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). pp 5-19 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18-19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

The life of erbium and titanium tritide targets used in a 10 mA, 300-keV accelerator has been measured. Various target holders are described, and the cost of neutrons from tritium targets is discussed. (auth)

37244 NEUTRON GENERATING TARGETS OF TRITIUM OR DEUTERIUM. Detaint, M. (CEN, Grenoble, France). pp 205-12 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18-19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3895; CONF-670960.

The deuterium enrichment in metallic films of Au, Ag, Cr, Ti, Y, and Yb was studied for deuteron beam currents from to 1 mamp to 300 keV. The results obtained are shown graphically and suggest that autotargets offer the possibility of producing only appreciable neutron fluxes. Of the metallic films studied, Yb was the best autotarget. (J.S.R.)

37245 DEMONSTRATION OF NEW TARGET DEVELOPMENT. Fabian, H. (NUKEM GmbH, Wolfgang, Ger.). pp 239-46 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In German).

See EUR-3895; CONF-670960.

Neutron-generating radiation targets which are available, and their forms, dimensions, and constructions are briefly illustrated. Cu-substrate targets are available in standard dimensions. Ti targets evaporated on substrates of Mo, Ta, W, Au, and Al are standardly produced. Targets of Er, Y, Sc, La, Ce, and Zr on Mo substrates are also available. The flanges and construction of typical targets are given. (J.S.R.)

37246 DESIGN STUDY FOR A GAS TARGET USING A ROTATING FOIL. Williamson, Frank S. (Argonne National Lab., Ill.). pp 165-79 of Proceedings of the 3rd Conference on Accelertor Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

There is a need for targets capable of accepting 1 milliampere of deuterons, at 3 MeV, for the production of monoenergetic neutrons. It is often an advantage for the neutron source area to be as small as possible even though a relatively large area is required for effective cooling. The greatest neutron output from the $D(d,n)^3He$ reaction is obtained from a gas target. The feasibility of a rotating gas target is studied. The deuteron beam enters a target chamber, containing deuterium gas at atmospheric pressure, through an annular nickel foil 10 cm in diameter and 0.5 cm wide. The foil is 1.27×10^{-4} cm thick. The target chamber, with the foil, rotates at 6000 r.p.m. The deuterium, which is an excellent cooling gas, enters and leaves the target chamber through concentric tubes which are coaxial with the annular foil. The gas is circulated by an external blower and is cooled by a conventional gas/water heat exchanger in a closed loop. The gas is constrained to flow across the foil radially, outward with a linear velocity of 50 meters/sec., then over cooling fins inside the target chamber casing and again radially inward to cool the part of this casing which absorbs the residual energy of the beam. Temperature rise in the gas from dissipation of the beam energy is about 80°C. Calculated foil temperatures vary, in the rotation cycle, from about 250°C to 450°C when only convection losses due to turbulent gas flow are considered. Additional heat losses, due to radiation and conduction, in the foil can be expected to reduce these temperatures somewhat. (auth)

37247 PERFORMANCE OF TARGETS IN SEALED-OFF NEUTRON TUBES. Hillier, M.; Lomer, P. D.; Stark, D. S.; Wood, J. D. L. H. (Services Electronics Research Lab., Baldock, Eng.). pp 125-45 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

Intense and long-lived sources of 14-MeV neutrons may best be achieved with sealed-off generator tubes. The evolution of targets for such tubes is discussed. Lives in excess of 100 hours have already been achieved at levels of 10^{10} and 10^{11} neutrons/second. At 10^{12} neutrons/second, lives of several hundred hours are foreseen. (auth)

37248 EXPERIENCE ACQUIRED IN THE GENERATION OF HIGH FLUXES OF 14-MeV NEUTRONS BY THE D–T REACTION. Luthardt, G. (Univ., Mainz). pp 113-23 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In German).

See EUR-3895; CONF-670960.

It is shown that 14-MeV neutron fluxes of $7 \cdot 10^{10}$ neutrons/cm^2/sec can be created in the irradiation position using Al vapor-deposited targets containing 20 Ci tritium/inch^2 with accelerator voltages of 500-600 keV and deuteron currents of 1000-1200 μA. These high fluxes are measured by means of the Cu(n,2n) reaction in calibrated beta and gamma counters and by means of the $Al(n,\alpha)^{24}Na$ reaction in a 4π-$\beta\gamma$ coincidence unit. The half-lives of the targets used vary from 3 to 15 hours according to the target currents. (auth)

37249 TARGET FOR HIGH-ENERGY IRRADIATIONS IN THE CYCLOTRON. Schultz, F.; Bellemann, H. (Kernforschungszentrum Karlsruhe, Ger.). pp 103-12 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In German). (KFK-685).

See EUR-3895; CONF-670960.

A target was developed in the Karlsruhe cyclotron which is suitable for high-energy irradiations on the inner beam. In this device the substance to be irradiated lies in the cooling water. The target can be exposed to currents of up to 100 μA at 50 MeV (deuterons). For the production of higher neutron fluxes beryllium is used as the target material. (auth)

37250 HIGH NEUTRON YIELD TARGETS FOR LINEAR ELECTRON ACCELERATOR. Allard, C. (EURATOM, Geel, Belgium). pp 75-102 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3895; CONF-670960.

A brief definition is given of the concept of the neutron yield of a target and the difficulty underlined of using all the power of an electron beam for the production of neutrons with 100% yield. The more the power increases, the more necessary it is to break up the heavy neutron-generating metal (uranium) in order to cool it, and the fraction of the cooling liquid becomes of even greater relative importance to the detriment of the neutrons produced. A description is also given of the principle of the target used at the BCMN, in which a special uranium arrangement makes it possible to obtain the maximum amount of neutrons with a high-power electron beam (10 kW). A description is also provided of the auxiliary rigs essential for this type of target, together with their measuring and safety circuits. Finally, the advantages and drawbacks of this type of target and the anticipated lines of future development are sketched on the basis of the latest results obtained. (auth)

37251 USE AND POSSIBILITIES OF TRITIUM AND DEUTERIUM TARGETS IN 150-keV PULSED ION ACCELERATOR AT LOW AVERAGE CURRENTS. Cordero, F. (Junta de Energia Nuclear, Madrid). pp 61-74 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

Measurements concerning deuterium and tritium targets suitable for a low-energy accelerator (150 keV) to obtain a pulsed neutron source are presented. The geometry and the operating conditions of the targets are described in connection with the study of the factors affecting the practical service life. Measurements of the rate of decrease in yield of neutrons from semi-thin tritium–titanium targets have been made. The yield falls rapidly to one-half when the integrated current reaches 0.7-1 coulombs (2.5 to 3 hours half-life at 50 μA); the neutron flux drops by about a factor of 10 after 5 C. No noticeable decrease in the target neutron yield is observed after ~50 C. By using deuterium–titanium targets with contamination of oil vapors the neutron yield increases until reaching saturation with ~70 C (~12 C/cm^2); subsequently, the yield remains constant. The processes which determine these results are discussed. (auth)

37252 A ROTATING HEAVY ICE TARGET FOR USE IN THE PRODUCTION OF FAST PROTONS BY THE $^3He(d,p)^4He$ REACTION. Bance, D. A. (Medical Research Council, Harwell, Eng.). pp 181-9 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

The development and performance of a heavy ice target for use with nuclear reactions involving the bombardment of deuterium is described. Evaporation of the heavy ice under bombardment is minimized by cooling with liquid nitrogen, by having the ice layer on an annulus of mean diameter 8 inches and width 1.75 in., which rotates continuously under the beam at 1000 r.p.m., and by scanning the beam at 100 kc/sec. so that the effective area is approximately 1.5 sq. inches. The target has been used for the $D(^3He,p)^4He$ reaction for production of 14.5 MeV protons for use in radiobiological research. Stable outputs have been obtained at 150 watts on target for several hours. The proton emission strength was 9×10^9 protons/sec. at this power. (auth)

37253 A ROTATING TARGET ASSEMBLY FOR 10^{12} NEUTRONS/SECOND. Cossuta, D. (Multivolt Ltd., Crawley, Eng.).

pp 191-204 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

A new high flux 14-MeV neutron source is described which was specially designed for use in fast neutron radiotherapy and for all applications requiring long irradiation times at a flux of the order of 10^{12} n/second. The design is based on a continuously rotating annular target assembly and is intended for use with accelerating machines providing several milliamperes at energies of some hundreds of kilovolts. Thermal effects and problems of heat dissipation are discussed in particular reference to the continuously mobile target surface. The parameters involved give useful information regarding performance which is expected from the present construction. Future development of this design is also briefly discussed. (auth)

37254 BACKGROUND PROBLEMS IN THIN HEAVY ICE TARGETS. Manero, F. (Junta de Energia Nuclear, Madrid). pp 213-23 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

Thin heavy ice targets have been used extensively as sources of monoenergetic neutrons especially for total neutron cross section measurements where the energy resolution of the neutron beam is of the greatest importance. This energy resolution can be worsened particularly by the background of spurious neutrons, as those produced at the target backing material, and mainly by the neutrons produced at the self-target formed by the loading of the target support with the deuteron beam. The importance of these backgrounds is studied. It is found that the contribution of the neutrons produced by the reaction of the deuterons with the target-support material can be considered negligible and can be omitted in any correction. On the contrary the contribution of the neutrons produced at the self-formed deuterium target is very important, and their number approaches that of the true target neutrons. The growth of the neutron background with bombarding time is studied, and it is shown that it tends to a saturation value which can be reached quite quickly. (auth)

37255 BERYLLIUM TARGET FOR NEUTRON PRODUCTION BY ^{9}Be(p,n) REACTIONS. Bodart, F.; Deconninck, G. (Univ., Louvain, Belgium). pp 225-37 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

The ^{9}Be(p,n) reaction has been studied between 2.5 and 4 MeV incident energy by a time of flight method. The different groups of neutrons have been separated and the cross sections measured at different angles and energies. The most important group of neutrons emerges from the ^{9}Be(p,n)^{9}B reaction which can be utilized as a source of monoenergetic neutrons in some conditions. The advantages and possibilities of a beryllium target are discussed. (auth)

37256 OPTIMISATION OF MODERATORS FOR PULSED NEUTRON TARGETS. Patrick, B. H.; Bowey, E. M.; Moxon, M. C.; Rae, E. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 291-304 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

In time-of-flight experiments, the source of neutrons in the energy range below ~100 keV is often a moderator placed next to a heavy element target which is injected with short bursts of charged particles. The effect of the moderator is usually to broaden the neutron pulse. Michaudon, in a series of Monte Carlo calculations, has estimated the magnitude of this effect. He has also shown that the moderator can be characterized at an energy E by a figure of merit F given by $F = N/\sigma^2$, where N is the number of neutrons leaving the moderator with energy E and σ^2 is the variance in the time distribution assuming that the contribution from the fast neutron pulse can be neglected. An experimental measurement of N and σ^2 as a function of moderator thickness at energies in the region of 100 eV and 1 keV is described. The experiment basically consisted of measuring the shape and area of neutron resonances by observing the capture γ-rays from a sample illuminated with a neutron beam leaving various thicknesses of polyethylene moderator. The experimental conditions were chosen so that the widths of the observed resonances were dominated by the moderator effects. A tantalum sample 0.004 in thick was used to study the 100 eV region and an iron sample 0.040 in thick for the 1 keV region. A Moxon-Rae detector on a 3.99 meter flight path was used to measure the γ-ray yield as a function of neutron energy. The results show that the neutron intensity, irrespective of time distribution, is a maximum for a thickness of 1.1 in polyethylene at ~100 eV and 1.0 in at ~1 keV. The full width at half maximum of the time distribution of the neutrons leaving the moderator (i.e., a quantity proportional to σ) increases with increasing moderator thickness and is 112 nsec at ~100 eV and 52 nsec in the 1 keV region for a thickness of 1 inch. The figure of merit has been calculated for the two energies and it is found that in each case it is a maximum for ~0.75 in polyethylene. These results are in reasonable agreement with the calculations of Michaudon. (auth)

37257 THE FAST NEUTRON FACILITY AT THE PRETORIA CYCLOTRON. Naude, W. J. (Univ. of Stellenbosch, S. Africa); Peisach, Max; Rautenbach, W. L. pp 261-82 of Proceedings of the 3rd Conference on Accelerator Targets Designed for the Production of Neutrons, Liege (Belgium), September 18–19, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3895; CONF-670960.

The construction of a beryllium target for use with the internal beam from the Pretoria 110-cm. cyclotron, as a neutron source, is described. The beryllium is mounted on a copper support through which a rapid current of cooling water flows. Samples for neutron irradiation are mounted in a cylindrical pipe in six positions from 6.5 to 23.6 cm from the beryllium and at angles from 14° to 70° to the direction of incidence of the charged particle beam. The pipe protrudes through the vacuum lock so that samples can be irradiated outside the vacuum system of the cyclotron. Activation reactions with thresholds between 1.8 and 20.3 MeV were used to calibrate the neutron flux. Ten reactions were so chosen that it was possible to use only 5 target materials, viz., KOH, Al, MgO, NH_4F and C. Thus only 6 irradiations were sufficient to measure the flux at each irradiation site. The activities were measured with a NaI(Tl) scintillation detector, the efficiency of which had been calibrated as a function of gamma-ray energy. Flux calibrations were performed on the neutrons emitted in the reaction ^{9}Be(d,n)^{10}B with 15.7 MeV deuterons and the reaction ^{9}Be(α,n)^{12}C with 31.8 MeV alpha particles. Total fluxes, depending on the irradiation site, ranged from 1.8×10^{8} to 2.1×10^{10} neutrons/cm^2-sec. The energy distribution was measured and found to be in excellent agreement with published data obtained from 15-, 24- and 26-MeV deuterons. Agreement was also good when the angular distribution of the emitted neutrons was compared with previously reported values. Total fast neutron emission from deuteron bombardment at 15.7 MeV was 2.28×10^{12} neutrons/sec per 100 μA. (auth)

37258 USE OF COSMIC RAYS FOR ESTIMATION OF EFFECTIVENESS OF BIOLOGICAL DEFENSES. Bondarenko, V. M.; Viktorov, G. G.; Tarkhov, A. G. At. Energ. (USSR), 24: 330-5 (Apr. 1968). (In Russian).

The results of the use of hard muon component of cosmic rays for determination of the density and mass of embankmenting of synchrophasotron annular building are discussed. The methods and processing technique of material are given. Brief response of recordings stations is described. (auth)

37259 CURRENT MEASUREMENT OF AN INTENSE ION BEAM WITH A COLLECTOR. Huizenga, W. (FOM-Instituut voor Plasma-Fysica, Rijnhuizen, Netherlands). Nucl. Instrum. Methods, 63: 109-13(July 15, 1968).

Current measurements on an intense ion beam by means of a collector are generally considered to be difficult and unreliable. This problem has been studied with pulsed ion beams of 0.6 up to 36 mA in the energy range between 5 and 15 keV with a collector provided with a secondary electron suppressing electrode. Observations show that the voltage needed to suppress completely escape of secondary electrons from the collector is approximately proportional to the space charge density of the beam in the collector entrance. The measured currents are considered to be reliable within 5%. (auth)

37260 BEAM-BUNCHING SYSTEM FOR A TANDEM ELECTROSTATIC ACCELERATOR USING SOLID STATE CIRCUITRY. Fauska, H.; Ward, N. G.; Lilley, J.; Williamson, C. F. (Univ. of Washington, Seattle). Nucl. Instrum. Methods, 63: 93-5 (July 15, 1968).

A solid state buncher chopper system for a tandem electrostatic accelerator is described. Ten percent of the normal H_2^+ beam from an exchange ion source is bunched to packets 6 ns fwhm on a target. The system was inexpensive to construct and is stable in operation. (auth)

37261 FOLDED TANDEM ACCELERATOR. Naylor, H. (Univ. of Auckland, N. Z.). Nucl. Instrum. Methods, 63: 61-5 (1968).

An unusual variety of tandem accelerator built within the structure of a single-ended electrostatic generator is described. Two acceleration tubes are placed side by side rather than end-to-end as in the conventional tandem, and a 180° magnet inside the high voltage terminal cover guides the beam between the tubes. Details of the terminal magnet and of the ion optics are given, together with a preliminary report on performance. (auth)

37262 100 MeV LINEAR ACCELERATOR INSTALLED AT GLASGOW UNIVERSITY. Blackett, P. M. S. (Univ. of Glasgow). Engineer, 225: 920-2(June 14, 1968).

The Glasgow 100-MeV electron linac is described. The modulators, klystrons, rf drive, accelerator waveguides, electron gun, and focus coils are briefly discussed. Features of the accelerator include a positron facility, short pulse facility, and variable energy capability. (W.H.K.)

37263 NON-UNIFORM MAGNETIC FIELD TYPE ELECTRON BEAM GENERATING DEVICE. (to Kobe Industries Corp.). British Patent 1,115,468. May 29, 1968. Priority date June 27, 1964, Japan.

An electron beam generating device which utilizes mutually perpendicular electric and magnetic fields is described. The design uses a nonuniform magnetic field to achieve a high intensity beam. This electron source may be used with cathode ray tubes, velocity modulating tubes, and electron accelerators. (W.H.K.)

37264 BETATRON OSCILLATION RESONANCES IN SYNCHROTRONS. Artem'eva, E. L.; Kulikov, O. F.; Metal'nikov, Yu. N.; Moroz, E. M.; Shorin, K. N. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 1, 12-16(Jan.-Feb. 1968). (In Russian).

The methods and the results of the experimental study of the betatron oscillation resonances in weak-focusing synchrotrons, working with maximum energy of 680 MeV, were reported. (tr-auth)

37265 PS SHUT DOWN. CERN Cour., 8: 97-8(May 1968).

A description of the major items of work which will be done on and around the 28-GeV proton synchrotron during the long shutdown which began on May 27 is presented. These include a new power supply for the PS magnet to increase beam intensity and general modifications on the linac, on the PS ring, in the experimental halls, and in the control room. (W.H.K.)

37266 LASER LINAC WITH GRATING. Takeda, Y.; Matsui, I. (Hitachi Ltd., Tokyo). Nucl. Instrum. Methods, 62: 306-10 (July 1, 1968).

A proposal for a laser linac with grating, is given for the miniaturizing of accelerators. A metal grating is used as periodic structure of the linac and as a reflector of a resonator of a laser device. Charged particles are accelerated by the intense electric field near the surface of the grating. The pitch of the grating and the wavelength of the laser must satisfy the phase matching condition for the particles and the field. A preliminary experiment was performed for a part of the proposal so that the giant pulse laser oscillation was observed. The surface of the grating was destroyed by the flux of the high power laser beam. Consideration on the appropriate materials are given for this purpose. (auth)

37267 CHARACTERISTICS OF HIGH-FREQUENCY SOURCES OF NEGATIVE HYDROGEN IONS OF OVERCHARGED PROTON INJECTOR. Dimov, G. I.; Sukhina, B. N. Prib. Tekh. Eksp., No. 1, 16-18(Jan.-Feb. 1968). (In Russian).

The high-frequency H^- ion source with a current of ~10 μamp designed for installation in the high-voltage electrode of the electrostatic accelerator, was described. The basic characteristics are: (a) comparatively low expenditure of gas, low feed output; (b) introduction of compensating overcharged tubes which make it possible to reduce the divergence of the beam because of the compensation of the space charge of the electrons and to reduce the beam of secondary electrons to the anode; (c) use of a spherical-type extraction system with optimum geometry, which reduces the collision of the ions on the extraction electrode and its pulverization. The source operated in the electrostatic accelerator for a year and did not get out of order. (tr-auth)

37268 ENHANCED BEAM POLARIZATION FROM A LAMB-SHIFT POLARIZED-ION SOURCE USING STATIC FIELD METHODS. Clegg, T. B.; Plattner, G. R.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Instrum. Methods, 62: 343-4(July 1, 1968).

A static field method has been used to increase the beam polarization from a Lamb-shift polarized-ion source. A proton beam with polarization $|P| = 0.78 \pm 0.02$ and a deuteron beam with polarizations $|P_3| = 0.49 \pm 0.02$, $P_{33} = 0.007 \pm 0.010$ have been obtained. A proposal is made which should allow a purely tensor polarized deuteron beam to be obtained from the Lamb-shift type source. (auth)

37269 RESONANT EXTRACTION FROM AN IDEAL CIRCULAR WEAK FOCUSING SYNCHROTRON. Conte, M. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods, 62: 269-75(July 1, 1968).

Computer calculations have been performed (being confined to the radial phase plane) to study how the optics of an ideal circular weak focusing synchrotron may be affected by a sextupolar second harmonic perturbation, either distributed or concentrated. A displacement of the resonant field index (corresponding to $Q_r = 3/2$) is found, as a function of the perturbation current. The rate of equivalence between the results obtained by these two types of distribution is discussed. A few data of interest for the extracted beam (extraction efficiencies, time structures and emittances) are evaluated by considering the oscillation amplitudes being brought up to resonance over realistic time intervals. (auth)

37270 PROPOSAL FOR DIRECT CONVERSION OF A POLARIZED ATOMIC BEAM TO POLARIZED NEGATIVE IONS. Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Instrum. Methods, 62: 355-7(July 1, 1968).

It is proposed to produce negative polarized ions of hydrogen or deuterium for injection into tandem accelerators by crossing a polarized beam of thermal hydrogen or deuterium atoms with a beam of fast neutral atoms or with a beam of negative ions. Polarized beams of high ion-optic quality with at least one μA intensity can be expected. (auth)

37271 FILMS OF SAMARIUM ISOTOPES FOR NUCLEAR INVESTIGATIONS. Lishenko, L. G.; Nazarova, T. S.; Reshetova, L. N.; Rozen, A. A. (Inst. of Physics and Engineering, Kharkov). Prib. Tekh. Eksp., No. 1, 19-20(Jan.-Feb. 1968). (In Russian).

A method for the preparation of thin (1 to 6μ) isotopic targets of Sm by means of metallothermal reduction of Sm_2O_3 with La in a vacuum was described. The original material Sm_2O_3 was first annealed in air at 1000°C, then the charge was degasified in vacuum for 20 to 25 hrs at 600°C and pressure of 4 to 6×10^{-4} torr. La, used for the experiment, was purified by zone fusion. The evaporation on the support was carried out at a pressure of 1×10^{-4} torr and a temperature of 1100°C. The results of the analysis of the films, obtained with different degasification times, were reported. Foils with the lowest gas content have a lustrous luminous surface, are pliable, and do not decompose during extended storage. (tr-auth)

37272 PREPARATION OF SELF-SUPPORTING TITANIUM FOILS. Chaudhri, M. Anwar (AEG Research Inst. Frankfurt am Main). Nucl. Instrum. Methods, 62: 316(July 1, 1968).

Thin 70–250 $\mu g/cm^2$ unsupported titanium foils are prepared by the standard vacuum deposition method. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 36037, 36077, 36124, 37238, 37239, 37244–37251, 37253–37257, 37345, 37619, and 37622.

37273 (AD-664026) ERGODIC THEORY AND DISCRETE TRANSPORT PROCESSES. Final Technical Report. Hejtmanek, H. (Oesterreichische Hochschule, Vienna. Atominstitut). Oct. 1967. Contract DAJA37-67-C-0959. 35p. CFSTI.

Discrete transport processes occur in the computational treatment of neutron transport problems in reactor physics and shielding. The time dependence of the particle density function, especially the asymptotic behavior of it, has been studied. Mean ergodic theory is applied to prove uniqueness of equilibrium. Then mixing and ergodicity of the transport process is established. (auth) (USGRDR)

37274 (AD-664790) MEASUREMENTS OF THE NEUTRON ANGULAR FLUX SPECTRUM IN GRAPHITE. Annual Report, October 1, 1965–September 30, 1966. Profio, A. E.; Antunez, H. M.; Williamson, T. G. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 30, 1966. Contract DA-49-146-XZ-482). 281p. (GA-7470). CFSTI.

Measurements of the neutron angular flux spectrum in graphite were made to provide a standard of comparison for neutron penetration calculations. The configuration approximated a point, fission-like source in an infinite medium. The spectrum from 0.002 eV to 15 MeV was measured with an accuracy of plus or minus 10% to plus or minus 20%, and resolution of ~10%, by the pulsed-source time-of-flight method. The source spectrum and other characteristics were also measured. Spectra were obtained at angles from 0 to 60° and penetrations to 66 cm. In addition, dieaway measurements, indium subcadmium and epicadmium flux traverses, sulfur and aluminum threshold foil traverses, and a threshold foil spectrum measurement were made. Procedures, apparatus, and results are described in detail so that others can evaluate our results and use them to test transport codes and input approximations. Comparison of the time-of-flight data with a preliminary discrete-ordinates calculation indicates fairly good agreement except for detail in the carbon resonance region, where the flux oscillates strongly. Both calculations and experiment indicate that the intermediate spectrum for r > 20 cm from the source is not 1/E as usually assumed. Low-energy foil activation and time-of-flight results are consistent, but threshold foils give poor results. (auth) (USGRDR)

37275 (AD-665378) SOLUTION OF THE STEADY-STATE DIFFUSION EQUATION USING GREEN'S FUNCTION. Banks, Norman E.; Blackshaw, G. Lansing (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Oct. 1967. 29p. (BRL-1374). CFSTI.

The one-velocity, one-dimensional, steady-state diffusion equation for a bare, spherical, neutron multiplying system containing a finite number of thin heterogeneities is formulated using a Heaviside representation for the spatial location of the heterogeneities. This Heaviside formulation is subsequently transformed to a Dirac delta function representation, and Green's function techniques are applied to determine flux solutions and critical conditions for the general case of multiple heterogeneities and the special case of a single heterogeneity located at one-half the radius of the spherical assembly. Correlations between the materials and geometric bucklings of subcritical, critical, and supercritical systems are graphically presented and discussed. (auth) (USGRDR)

37276 (AERE-R-5364) MEASUREMENTS OF FAST NEUTRON SPECTRA IN REACTOR MATERIALS. Coates, M. S.; Gayther, D. B.; Goode, P. D. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1968. 38p. Dep. CFSTI. UK 8s. 0d.

A series of neutron energy spectra emerging from spherical shells of natural uranium, polyethylene, graphite and sodium were measured in the energy region 300 eV to 6.5 MeV. The time-of-flight method was used with a 60-m path and a pulse source of fast neutrons provided by the 45-MeV linear accelerator. The source was located at the centre of the shell and spectra leaving the surface at 0 and 45° to a radius vector were determined. In addition a few measurements were made of spectra in the 0° direction from different penetration depths into the shell wall. The source was designed to emit neutrons isotropically, and the aim of the measurements was to provide spectra in simple one-dimensional systems in order to test the nuclear data sets used in reactor calculations. The experimental method is described in detail, and some comparisons based on discrete ordinate solutions of the Boltzmann equation are presented. (auth)

37277 (AI-AEC-Memo-12645) TRIX-1, 1A, FORTRAN H OPERATING INSTRUCTIONS. Otter, J. M. (Atomics International, Canoga Park, Calif.). Jan. 18, 1968. 47p. Dep. CFSTI.

Operating instructions for the codes TRIX-I and TRIX-IA for calculating Doppler-broadened, self-shielded cross sections are described. Also the current resonance parameter library is listed. (W.H.K.)

37278 (GEMP-617) PROGRAM TNDT (NS0896): A CODE TO PREPARE A 16-GROUP NUCLEAR DATA TAPE FOR TRANSPORT CODES DTF-IV AND 2DF. Henderson, W. B.; Robertson, C. S. Jr. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). June 6, 1968. Contract AT(40-1)-2847. 28p. Dep. CFSTI.

The program TNDT (NS0896), a FORTRAN-IV code which prepares a 16-group nuclear data tape for use by the DTF-IV and 2DF transport codes, is described. The data for an isotope, element, or material, on cards in one of four allowed formats, are put on the new tape together with selected data from an existing tape. In addition to tape listings, punched cards can be requested containing the 16-group cross sections for any mixture of tape species weighted by density and group effective "g" factors. The punched cards can be used directly as input to the transport codes or for addition to the tape. (auth)

37279 (IN-1141) SLOW NEUTRON SCATTERING FROM WATER. Brugger, R. M.; Plummer, J. P. (Idaho Nuclear Corp., Idaho Falls). May 1968. Contract AT(10-1)-1230. 28p. Dep. CFSTI.

Neutrons of 0.05-eV energy were inelastically scattered from samples of water. The experiment was arranged so that a correction could be made for multiple scattering and so that the observed scattering law would be measured at momentum change $\hbar\kappa$ smaller than obtained in previous experiments. From the data it is concluded that at these low κ values the scattering law at fixed β is proportional to κ as predicted by the McMurry-Russell model but by no other models, that discrete transitions are no more distinct at these smaller κ's than at larger κ's contrary to the predictions of the McMurry–Russell model, that multiple scattering is important but not as large as predicted, and that accurate experimental corrections can be made for multiple scattering. (auth)

37280 (LA-3478(Pt.1)) TIME-OF-FLIGHT NEUTRON CROSS-SECTION MEASUREMENTS MADE WITH NEUTRONS FROM NUCLEAR EXPLOSIONS. Hemmendinger, A.; Diven, B. C.; Brown, W. K.; Ellis, A.; Furnish, A.; Shunk, E. R.; Fullwood, R. R. (Los Alamos Scientific Lab., N. Mex.). Dec. 10, 1967. Contract W-7405-eng-26. 26p. Dep. CFSTI.

Well-known laboratory techniques have been adapted to meet the specific requirements of neutron time-of-flight measurements using as a source the neutrons emitted in a nuclear detonation. The experimental arrangements and hardware are described, with particular attention to parameters affecting neutron flux and energy resolution. Details of instrumentation and data recording schemes are presented. (auth)

37281 (NYO-72-191) PEGRAM NUCLEAR PHYSICS LABORATORIES PROGRESS REPORT FOR JANUARY 1967–JANUARY 1968. (Columbia Univ., New York. Dept. of Physics). Apr. 25, 1968. Contract AT(30-1)-Gen-72. 196p. Dep. CFSTI.

Neutron resonance parameters for several isotopes of Er and Yb were determined, and methods were developed for solving the neutron transport equation in its integral and stationary forms. The effect of the 1/v and non-1/v capture cross sections on neutron thermalization was studied, and a theoretical study of the level structure of ^{17}O was completed. Methods for making neutron penetration calculations were investigated, and the neutron total scattering cross sections of hydrogenous compounds were measured. The lifetimes of energy levels in ^{10}Be and ^{14}N were measured; and isobaric analog resonances in proton elastic scattering by ^{76}Ge, ^{76}Se, ^{78}Se, ^{80}Se, and ^{82}Se were investigated. Nuclear charge distributions and transition quadrupole moments in ^{162}Dy, ^{164}Dy, ^{168}Er, ^{170}Er, ^{150}Nd, ^{152}Sm, ^{182}W, ^{184}W, and ^{186}W were determined by observation of x-ray spectra of μ-mesic atoms. Isotope shifts in the x-ray spectra of μ-mesic atoms of Cr, Mo, and Nd were also observed. Data acquisition equipment for neutron time-of-flight experiments was developed, as was a time-of-flight system for

integral thermalization experiments using pulsed sources. A velocity window discriminator for Moessbauer spectrometers was also developed. Development of low-noise charge-sensitive preamplifiers and of a data acquisition system for studying resonance neutron-induced fission of ^{233}U is also reported. (D.C.W.)

37282 (RFP-1133) EFFECTS OF SPATIAL RESOLUTION ON CRITICAL MASS CALCULATIONS. Coonfield, Donald C.; Hunt, Douglas C. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). May 31, 1968. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

A systematic study is presented of the effects of spatial resolution on critical mass calculations. The critical assemblies considered were reflected and moderated uranium-metal systems. The calculations were done by varying the spatial mesh in the transport-theory, Computer Code DTF II. The results are compared with experimentally measured critical masses. The conclusion is that proper handling of spatial resolution in these types of critical systems can significantly improve the agreement between theory and experiment. (auth)

37283 TEMPERATURE DEPENDENCE OF THE COHERENT EXTINCTION FOR NEUTRON SCATTERING ON SINGLE CRYSTALS. Brosch, R.; Rauch, H. (Atominstitut der Oesterreichischen Hochschule, Vienna). Atomkernenergie, 13: 183-7(May-June 1968). (In German).

The temperature dependence of parasitic reflections on the Bragg-reflected neutron intensity was determined. The measurements were done with a lead single crystal at room temperature and 80°K. The crystal, which was mounted in a N_2 cryostat could be rotated around the Bragg position and around an axis perpendicular to the (200) main reflecting plane. The observed intensity losses ("Aufhellungen") ranged to 15% of the extinction free intensity. The temperature dependence is especially striking for second-order scattered neutrons, where the intensity losses caused by coherent extinction at 80°K increase to 150% over the intensity losses observed at room temperature. The experimental results are in good agreement with the theoretical ones. (auth)

Nuclear Properties and Reactions, A≤5

Refer also to abstracts 37162 and 37389.

37284 (UCRL-18137) PROTON-^{3}He POLARIZATION IN THE RANGE FROM 10 TO 20 MeV. Tivol, William F. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1968. Contract W-7405-eng-48. 87p. Dep. CFSTI.

Thesis.

Using the polarized beam facility of the 88-inch isochronous cyclotron at Berkeley, the polarization of protons in the elastic scattering of polarized protons on ^{3}He was investigated. Four pairs of detectors were arranged around a target gas cell to count protons. These consisted of phototubes on which were mounted CsI crystals ground to a thickness approximately 50% greater than the range calculated for the protons. The signals from the detectors were routed into two 400-channel pulse height analyzers thereby separating the elastic peak from inelastic background. Backgrounds were low enough to permit an unambiguous treatment of the spectra. A solenoid magnet was used to flip the protons' spins in order to cancel any geometric asymmetries. The target gas cell was operated at 60 psi with a window of 1.9 mil dural for the higher energies, and at 20 psi with a 1 mil dural window at lower energies. At one energy points were taken with both operating conditions. Polarization as a function of angle for approximately twenty points was obtained for each of five energies in the range from 10 to 20 MeV by measuring the right-left asymmetry in the differential cross section. The results are similar to the polarization in p-α scattering which seems to indicate that spin-orbit effects are large. Phase-shift analysis of the data shows no apparent regularities; however, all indications are that much more data are needed to determine the phase shifts accurately. In particular, triple scattering experiments, which determine spin correlation parameters, are especially necessary. (auth)

37285 MEASUREMENTS OF THE DIFFERENTIAL CROSS SECTION AND POLARIZATION IN PROTON-PROTON SCATTERING AT ABOUT 98 MeV. Wigan, M. R. (Oxford Univ.); Bell, R. A.; Martin, P. J.; Jarvis, O. N.; Scanlon, J. P. Nucl. Phys., A114: 377-91(1968). (AERE-R-5685).

The differential cross section and polarization in proton-proton scattering were measured over the angular range 16.4 to 96.5°c.m. at mean scattering energies of about 98 MeV. The cross sections were determined to within a relative precision of about ±1%, with a further over-all normalization error of ±1.0%. The asymmetry measurements were made to a precision of better than ±0.002, and the beam polarization is known from previous work to an accuracy of ±0.85% of its value. (auth)

37286 Λ-Σ CONVERSION AND THE HYPERTRITON. Schick, L. H.; Toepfer, Alan J. (Univ. of Southern California, Los Angeles). Contract AT(04-3)-136. Phys. Rev., 170: 946-51 (June 20, 1968). (USC-136-131).

The binding energy of $_\Lambda H^3$ is calculated using a Faddeev-type multiple-scattering formalism. The effects of virtual Λ-Σ conversion via ΛN↔ΣN are included in a full two-channel representation of the YN interaction. Nonlocal separable, s-wave, spin-dependent potentials are used for each two-body interaction. Calculations are performed for two sets of low-energy ΛN scattering parameters and two different symmetry models for the YN potential. The introduction of Λ-Σ conversion in the YN spin-triplet channel increases the binding energy. The binding is decreased by the use of Λ-Σ conversion in the YN spin-singlet channel. When incorporated into both YN spin channels, the effect of Λ-Σ conversion is to reduce the $_\Lambda H^3$ binding energy. (auth)

37287 FADDEEV EQUATIONS AND COULOMB EFFECTS IN ^{3}He. Alessandrini, V. A.; Garcia, C. A. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 170: 935-45(June 20, 1968). (IC-68/5).

When two particles interact via a potential V which is the sum of a separable potential V_s and a Coulomb potential V_c, the two-body T matrix can be obtained exactly and can be split in the usual way into a pure Coulomb T matrix and a "nuclear" T matrix which also contains Coulomb effects. Using the fact that the "nuclear" T matrix is still separable in the off-shell variables, the formalism of Alt, Grassberger, and Sandhas is applied to the calculation of Coulomb effects in the three-nucleon system, with the contribution of the nonseparable Coulomb T matrix fully taken into account. The Coulomb energy Δ_c of ^{3}He and the probability $P_{\frac{1}{2}}$ of finding the ^{3}He in an $I = \frac{1}{2}$ state are calculated, using s-wave spin-dependent potentials of the Yamaguchi type to describe the two-nucleon interaction. This model yields values for Δ_c which are in reasonable agreement with the binding-energy difference of ^{3}H and ^{3}He, but predicts a negligible admixture of the $I = \frac{1}{2}$ state in the ^{3}He wave function. The effect of the nonseparable part of the p-p T matrix on the binding energy and wave function of ^{3}He is discussed. Finally, the possible relevance of hard-core effects is pointed out. (auth)

37288 RADIATIVE NEUTRON-DEUTERON CAPTURE AND THE BOUND AND SCATTERING STATES OF THE THREE-NUCLEON SYSTEM. Phillips, A. C. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 170: 952-7(June 20, 1968).

The capture of thermal neutrons by deuterons is found to be sensitive to three-body scattering effects in the initial neutron-deuteron state. The interaction effect is also important. But theoretical errors associated with this effect prevent any detailed conclusions with regard to the implications of the capture reaction for the 3-nucleon bound-state wave function. However, a simple phenomenological representation of the interaction effect, which is consistent with the 3-nucleon exchange magnetic moments and neutron-proton capture, is sufficient to reconcile the results of neutron-deuteron capture with present knowledge of the 3-nucleon bound state. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 37090, 37281, 37338, 37340, and 37628.

37289 (AERE-R-5224) THE AVERAGE NEUTRON TOTAL CROSS-SECTION OF ^{10}B FROM 100 eV TO 10 MeV AND ABSORPTION CROSS-SECTION UP TO 500 keV. Diment, K. M. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1967. 17p. Dep. CFSTI. UK.

The transmission measurements to be described were made on the 120-m and 300-m flight paths of the Electron Linac time-of-flight spectrometer at Harwell. Analysis of the total cross section below 10 keV shows $\sigma_{n,T} = (610.3 \pm 3.1)\ E^{-\frac{1}{2}} + (1.95 \pm 0.10)$ barns. The deviation of $\sigma_{n,T}$ from this value above 40 keV is due to an increase in elastic scattering cross section. Subtraction of the latest scattering cross sections measured by Mooring et al. yields an absorption cross section that is proportional to $E^{-\frac{1}{2}}$ up to at least 250 keV. (auth)

37290 (ANU-P-406) TENSOR POLARIZATION OF DEUTERONS FROM ^{12}C-d ELASTIC SCATTERING. Cords, H.; Din, G. U.; Ivanovich, M.; Robson, B. A. (Australian National Univ., Canberra. Research School of Physical Sciences). [1967]. 18p. Dep.

The spin tensor moments $\langle T_{20}\rangle$, $\langle T_{21}\rangle$, and $\langle T_{22}\rangle$ of deuterons from ^{12}C-d elastic scattering were measured utilizing the ^{3}He(d,p)^{4}He reaction as an analyzer of deuteron polarization. The three deuteron polarization parameters are presented as functions of incident deuteron energy between 3.5 and 7.1 MeV at 37.5° and 45° scattering lab angles. The tensor moments are also presented as functions of scattering angle between 22.5° and 75° lab angles in steps of 7.5° at 5.25, 6.10, and 7.05 MeV deuteron incident energies. An optical model analysis which includes tensor terms in the deuteron potential was performed. (auth)

37291 (ORNL-TM-2267) THE ^{14}N(n,n'γ) REACTION FOR $5.8 \leq E_n \leq 8.6$ MeV. Dickens, J. K.; Eichler, E.; Perey, F. G.; Stelson, P. H.; Ashe, John; Nellis, D. O. (Oak Ridge National Lab., Tenn.). June 21, 1968. Contract W-7405-eng-26. 25p. Dep. CFSTI.

Gamma-ray spectra for the reactions ^{14}N(n,n'γ)^{14}N, ^{14}N(n,pγ)^{14}C and ^{14}N(n,αγ)^{11}B for incident mean neutron energies E_n = 5.8, 6.4, 6.9, 7.4, 8.0, and 8.6 MeV were obtained. The gamma rays were detected using a coaxial Ge(Li) detector of 30 cc active volume. The detector was placed at 55° and 90° with respect to the incident neutron direction, and was 77 cm from the sample; time-of-flight was used with the gamma-ray detector to discriminate against pulses due to neutrons and background gamma radiation. The sample was 100 gm of Be_3N_2 in the form of a right circular cylinder. Data were also obtained using a 75-gm Be sample to provide an estimate of the background. The incident neutron beam was produced by bombarding a deuterium-filled gas cell with the pulsed deuteron beam of appropriate energy from the ORNL 6-MV Van de Graaff. The resulting neutron beam was monitored using a scintillation counter; a time-of-flight spectrum from this detector was recorded simultaneously with the gamma-ray data. These data were studied to obtain absolute cross sections for production of gamma rays from ^{14}N for the incident neutron energies quoted above. (auth)

37292 (UCRL-18263) AN INVESTIGATION OF THE (^{3}He,t) AND (^{3}He, ^{3}He') REACTIONS ON 1p SHELL NUCLEI. Ball, Gordon Charles (California Univ., Berkeley. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 143p. Dep. CFSTI.

Thesis.

The (^{3}He,t) and (^{3}He,^{3}He') reactions on ^{9}Be, ^{12}C, ^{13}C, ^{14}C [(^{3}He,t) reaction only], ^{14}N, and ^{15}N were investigated at ^{3}He energies of 39.9, 49.8, 39.6, 44.8, 44.6, and 39.8 MeV, respectively. Angular distributions were obtained for all prominent states up to excitations of 20 MeV. A microscopic analysis of these data was carried out using a local two-body interaction with an arbitrary spin-isospin exchange mixture. Spectroscopic factors were calculated using intermediate-coupling wave functions for p shell states while simple j-j configurations were assumed for the levels which were populated by promoting a p nucleon to the s-d shell. A Yukawa interaction with a range of α^{-1} = 1.2 F was found to give the best results. The strength of the effective nucleon–nucleon interaction required to fit these data is in good agreement with recent (p,p'), (p,n) and (^{3}He,t) calculations on light nuclei. In particular, dominant L = 0 transitions observed in the (^{3}He,t) reaction gave values for the isospin $V_{ST} = V_{01}$ and spin-isospin V_{11} dependent terms (converted to an effective nucleon–nucleon interaction at α^{-1} = 1.0 F) of 20.6 and 16.5 MeV, respectively, while the strengths required to fit (^{3}He,t) L = 2,3 transitions were generally enhanced. For inelastic transitions, the average strengths obtained for V_{00}, assuming a Serber exchange mixture, varied from 47.2 to 67.3 MeV depending upon the L transfer involved. A comparison of the (^{3}He,t) and (^{3}He,^{3}He') reactions populating analog final states (where $T_f = T_i + 1$) is also presented. In general, these transitions were weakly populated; however, it was possible to observe the lowest T = ½ levels in the mirror nuclei ^{9}B – ^{9}Be and ^{13}N – ^{13}C and several T = 1 levels in ^{12}N–^{12}C. 98 references. (auth)

37293 DEUTERON-INDUCED REACTIONS ON ^{16}O. Dietzsch, O. (Univ., Sao Paulo, Brazil); Douglas, R. A.; Pessoa, E. Farrelly; Porto, V. Gomes; Hamburger, E. W.; Polga, T.; Sala, O.; Perez, S. M.; Hodgson, P. E. Nucl. Phys., A114: 330-52(1968).

Absolute differential cross sections were measured for the reactions ^{16}O(d,d)^{16}O, ^{16}O(d,p)^{17}O (ground state), ^{16}O(d,p)^{17}O* (0.87 MeV), ^{16}O(d,n)^{17}F (ground state), ^{16}O(d,n)^{17}F* (0.50 MeV), and ^{16}O(d,α)^{14}N (ground state) from 2 to 3.5 MeV. Excitation functions were obtained at several angles, and angular distributions were measured at sufficiently small energy intervals to determine the structure in the cross sections. These data are analyzed using the optical model, the Hauser–Feshbach theory, and the distorted-wave Born approximation. The fluctuations of the (d,d) and (d,p) cross sections with incident deuteron energy are analyzed to give the compound nucleus and direct interaction contributions to these reactions. (auth)

37294 EXPONENTIALLY VELOCITY-DEPENDENT POTENTIAL IN THE SHELL MODEL OF ^{18}O. Ganas, P. S. (Univ. of Sydney). Phys. Rev., 170: 879-82(June 20, 1968).

The low-lying energy levels of ^{18}O are calculated in the harmonic-oscillator shell model using as residual interaction the exponentially velocity-dependent singlet-even potential of Tabakin and Davies in combination with the triplet-odd potential of Green. The main result is that the energy levels so calculated agree closely with the energy levels of Kuo and Brown calculated without core polarization from the hard-core Hamada–Johnston nucleon-nucleon potential. (auth)

37295 CONTINUUM NUCLEAR STRUCTURE OF ^{16}O IN THE EIGENCHANNEL REACTION THEORY. Wahsweiler, H. G. (Univ., Frankfurt am Main); Greiner, Walter; Danos, Michael. Phys. Rev., 170: 893-906(June 20, 1968).

The total particle-particle S^J matrix of ^{16}O for spin $J = 1^-$ and excitation energies between 15 and 27 MeV was calculated in the eigenchannel reaction theory for several parameters of the Saxon–Woods potential and the two-body force. The many-body problem was treated in the 1-particle–1-hole approximation. The photon channels were included by perturbation theory. Surprisingly, the most important structure of the experimental cross sections is reproduced quite well in this simple approximation. (auth)

37296 (α,Li) REACTIONS ON ^{11}B, ^{15}N, AND ^{19}F. Mizera, P. F.; Gerhart, J. B. (Univ. of Washington, Seattle). Phys. Rev., 170: 839-46(June 20, 1968). (RLO-1388-34).

Differential cross sections for (α,^{7}Li) and (α,^{7}Li* 0.478) reactions were measured on ^{11}B to the ground state of ^{8}Be, on ^{15}N to the ground and first excited states of ^{12}C, and on ^{19}F to the ground state of ^{16}O, using 42-MeV α particles. In addition, the (α,^{6}Li) reaction was studied on ^{15}N, leading to the ground state of ^{13}C and on ^{19}F, leading to the ground and first excited states of ^{17}O. A zero-range distorted-wave Born-approximation (DWBA) code was used to fit the (α,^{7}Li) angular distributions assuming a one-step pickup mechanism. Triton reduced widths are extracted from the DWBA calculations normalized to the experimental differential cross sections, and then compared with approximate shell-model calculations. The comparison between the extracted and calculated reduced widths shows that ^{11}B, ^{15}N, and ^{19}F are probably consistent with a single-particle interpretation, although a small enhancement for triton clustering is observed for the ground state of ^{19}F. (auth)

37297 NEUTRONS FROM ^{9}Be(α,n) REACTION FOR E_α BETWEEN 6 AND 10 MeV. Verbinski, Victor V.; Perey, Francis G.; Dickens, J. Kirk; Burrus, Walter R. (Oak Ridge National Lab., Tenn.). Phys. Rev., 170: 916-23(June 20, 1968). (ORNL-P-3393).

Absolute differential cross sections were measured as a function of angle and α bombarding energy for the reaction ^{9}Be(α,n)^{12}C leaving ^{12}C in its ground, first excited, and second excited states. The angular distribution for the ground-state (0+ state) transition changed from a fore-aft peaking at E_α = 6.8 MeV to a three-peaked angular distribution at E_α = 9.9 MeV. Similar behavior was observed for the second-excited-state transition (0+). The angular distribution for the first-excited-state transition (2+) displayed fore-aft peaking and was not sensitive to bombarding energy. A strong, low-energy component, present at forward angles at all bombarding energies, can be accounted for by three- and four-body breakup reactions. (auth)

37298 STUDY OF SOME ^{12}C(^{3}He,α)^{11}C REACTIONS AT 13.9 MeV. Ober, D. R.; Johnson, O. E. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 170: 924-31(June 20, 1968). (COO-1746-2).

The 13.9-MeV angular distributions for the ^{12}C(^{3}He,α)^{11}C reactions which produce the ground, 2.00-, 4.32-, and 4.81-MeV states of ^{11}C were measured, using silicon surface-barrier detectors. The differential cross sections were determined at 2.5° intervals over a laboratory angular range from about 15° to 100°. The angular distributions display features which suggest that a direct-reaction mechanism is operative. The ground-state angular distribution is strongly peaked at forward angles with a weak washed-out oscillatory structure, and those for the excited states are also forward-peaked, but have a strong, well-defined oscillatory nature. The integrated cross sections over the common center-of-mass angular range (32 to 112°) for the ground and first three excited states are 30.5, 9.2, 9.7, and 11.9 mb, respectively. Each angular distribution was analyzed in terms of both zero-range distorted-wave Born-approximation knockout and pickup models. Reasonable correspondence between theory and experiment for the ground-

state ($3/2^-$) and second-excited-state ($5/2^-$) angular distributions was achieved only with the pickup model, while only the knockout model provided a reasonable representation of the angular distributions corresponding to the first ($1/2^-$) and third ($3/2^-$) excited states. (auth)

37299 THE INELASTIC SCATTERING OF ELECTRONS FROM LIGHT NUCLEI. Drake, Thomas Edward. Saskatoon, Univ. of Saskatchewan, 1967. 142p.

Thesis.

When an electron is scattered from a target nucleus a "virtual photon" is transferred exciting the nucleus to some single isolated state of spin and parity $J_f^{\pi_f}$. By changing the incident energy of the electron beam the wavelength λ of the probing photon can be varied and a diffraction pattern for each state is measured. The momentum transferred to the nucleus is $q = 2\pi/\lambda$ and the behavior of the diffraction pattern in the limit as $q \to 0$ gives the spin l of the transition. A plot of the level (strength) as a function of $\tan^2 \theta/2$, where θ is the electron scattering angle, gives the parity π of the transition. Thus the technique of electron scattering is capable of measuring the spin and parity, $J_f^{\pi_f}$, and a diffraction pattern for each isolated level in the target nucleus. The reproduction of these diffraction patterns provide an excellent test for any proposed nuclear model. With this in mind a study was initiated of all the dominant isolated $J_f^{\pi_f}$ levels just below and in the giant resonance region of nuclear excitation in the light closed shell nuclei ^{12}C, ^{16}O, ^{28}Si and the off shell nucleus ^{9}Be. The main theme of this thesis is focused on the $J_f^{\pi_f} = 2^-$ (magnetic quadrupole) and the 1^+ (magnetic dipole) transitions in these nuclei. Theoretical calculations of the diffraction maxima and minima are sensitive to the model parameters, and are particularly sensitive to the parameters of the single-particle wavefunctions. The theoretical calculations of Stamp and Mayer (1966) are extended to give a diffraction pattern for the 19.08-MeV level in ^{16}O. This provides an excellent example of how parameters may be chosen to give reasonable state energies but unreasonable diffraction patterns. The diffraction pattern for the $J_f^{\pi_f} = 1^+$, 11.4-MeV level in ^{28}Si has been extended out to the first diffraction minimum. The diffraction pattern for the "20.5-MeV level" in ^{16}O was measured and it is proposed that $J_f^{\pi_f} = 1^+$ be assigned to it. Measurements on other levels in ^{16}O, ^{28}Si and ^{9}Be were also performed and are presented. A Coulomb continuum has been discovered beneath the level peaks in ^{12}C and ^{16}O from 15 to 22 MeV. This is the first measurement of this phenomenon which to date has no theoretical explanation. (Diss. Abstr.)

37300 GAMMA-RADIATION INVESTIGATION IN THE REACTION $^{12}C(^3He,p\gamma)^{14}N$. Mareev, Yu. D.; Osetinskii, G. M.; Savitska, B.; Sizov, I. V.; Yazvitskii, Yu. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 33: 595-604(Apr. 1968). (In Russian).

The γ radiation from the reaction $^{12}C(^3He,p\gamma)^{14}N$ was investigated. Using the Doppler broadening of the spectral peaks, upper limits were determined for the lifetimes of six levels in ^{14}N. On the basis of the analysis of the γ angular distributions, spin assignments for several excited states in ^{14}N and ^{15}O were proposed. (tr-auth)

37301 FORMATION OF LITHIUM AND BERYLLIUM NUCLEAR FRAGMENTS IN THE INTERACTIONS OF 125-MeV PROTONS WITH TARGETS OF CARBON AND NITROGEN. Jung, Monique; Jacquot, Claude; Baixeras-Aiguabella, Carmen; Schmitt, Roger; Braun, Henri (Centre de Recherches Nucleaires, Strasbourg-Cronenbourg, France). Compt. Rend., Ser. A and B, 266: 1154-7(Apr. 22, 1968). (In French).

An experimental study of the production cross sections of the elements ^6He, ^6Li, ^7Li, ^7Be, ^9Be, and ^{10}Be was made with carbon and nitrogen targets with the purpose of determining the isotopic ratios of interest in astrophysics. (tr-auth)

37302 STRUCTURE OF ^{16}O. Zuker, A. P. (Brookhaven National Lab., Upton, N. Y.); Buck, B.; McGrory, J. B. Phys. Rev. Lett., 21: 39-43(July 1, 1968).

An exact shell-model calculation is presented that gives a good description of the properties of ^{16}O and neighboring nuclei. (auth)

37303 LEVEL STRUCTURE IN ^{15}O FROM THE PROTON BOMBARDMENT OF ^{14}N. West II, Martin Luther. Austin, Tex., Univ. of Texas, 1967. 106p.

Thesis.

Absolute differential cross sections for the elastic and inelastic scattering of protons by ^{14}N were measured at laboratory angles of 67.5, 85.9, 105.8, 123.7, 135.0, and 157.5° for bombarding energies between 3.7 and 5.7 MeV. In addition, angular distributions were measured at 21 selected energies. Thirteen resonances were observed in the elastic scattering cross section, and five of these had appreciable partial widths for the $^{14}N(p,p_1)^{14}N^*$ reaction. An attempt was made to fit these data using a multilevel R-matrix approximation. A computer code based on the R-matrix "two-level" approximation was written for calculation of the elastic cross sections. Extensive computations were performed with this code using the inelastic data as an aid in choosing trial resonance parameters. Unfortunately, it has not been possible to produce an exact fit to the data due to uncertainties in the off-resonance background. This background is usually assumed to be of the hard-sphere type, which gives rise to a set of adjustable spin-independent potential phase shifts. No set of spin-independent phase shifts could be found that would adequately fit the six elastic scattering excitation functions in the off-resonance regions. However, a study of resonance shapes has shown that the general shape of resonances is not sensitive to changes in these background phase shifts. Thus it was possible to deduce resonance parameters for some of the resonances by making qualitative fits to the elastic scattering excitation functions. (Disser. Abstr.)

37304 ACCURACY OF THE PROJECTION METHOD. Gunye, M. R. (McMaster Univ., Hamilton, Ont.). Phys. Lett., 27B: 136-9(June 24, 1968).

The accuracy of the projection method to obtain good angular momentum states from the deformed Hartree-Fock states is tested by comparing the results of the spectroscopic calculations by this method with those obtained by the shell model. (auth)

37305 PHENOMENA PECULIAR TO NUCLEAR MOLECULAR POTENTIALS IN $^{16}O + ^{16}O$ SCATTERING. Munn, R. J. (Univ. of Maryland, College Park); Block, B.; Malik, F. B. Phys. Rev. Lett., 21: 159-62(July 15, 1968).

Elastic-scattering calculations for $^{16}O + ^{16}O$ by real molecular-type potentials were carried out over energies 8 to 30 MeV (cms). The cross sections are too large, although they show the erratic behavior expected in the orbiting energy range. A Blair approximation with an absorbing core of 3- to 4-F radius on these molecular-potential phase shifts gives the correct magnitude and energy dependence of the excitation function from 17 to 26 MeV. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 36135, 37090, 37281, 37304, 37338, 37340, and 37387.

37306 (AD-665359) NEUTRON AND GAMMA RAY PRODUCTION CROSS SECTIONS FOR SODIUM, MAGNESIUM, CHLORINE, POTASSIUM, AND CALCIUM. PART I. GENERAL INFORMATION AND DATA FORMAT. Drake, M. K.; Garrison, J. D.; Allen, M. S. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 1967. Contract DA-18-035-AMC-730(A). 38p. (GA-7829(Pt.1); NRL-TR-89(Pt.1)). CFSTI.

Sets of neutron and gamma ray production cross sections have been prepared for sodium, magnesium, chlorine, potassium, and calcium. The recommended sets of cross sections have been written on magnetic tape in the AWRE-AEEW format. This report gives some general information on how the evaluations were done and also on how the AWRE-AEEW format was expanded such that gamma-ray production cross sections could be included. Data for the individual elements are given in AD-665 360, AD-665 361, AD-665 362, AD-665 363, and AD-665 364. (USGRDR)

37307 (AD-665360) NEUTRON AND GAMMA RAY PRODUCTION CROSS SECTIONS FOR SODIUM, MAGNESIUM, CHLORINE, POTASSIUM, AND CALCIUM. PART II. SODIUM. Garrison, J. D.; Drake, M. K. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 1967. Contract DA-18-035-AMC-730(A). 148p. (GA-7829(Pt.2); NDL-TR-89(Pt.2)). CFSTI.

Neutron and gamma-ray production cross sections sets were prepared for the element sodium. These data sets include total and partial neutron cross sections as well as the cross sections for producing deexcitation gamma rays. Information is also given for the angular and energy distribution of the secondary neutron and gamma rays. (auth) (USGRDR)

37308 (AD-665361) NEUTRON AND GAMMA RAY PRODUCTION CROSS SECTIONS FOR SODIUM, MAGNESIUM, CHLORINE, POTASSIUM, AND CALCIUM. PART III. MAGNESIUM. Drake, M. K. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 1967. Contract DA-18-035-AMC-730(A). 191p. (GA-7829(Pt.3); NDL-TR-89(Pt.3)). CFSTI.

An investigation was made of the neutron interaction probabilities

with the element magnesium. Sets of recommended total and partial neutron cross sections were prepared. The energy and angular distributions of the secondary neutrons are given. Also, gamma-ray production cross sections were obtained as well as energy and angular distributions of the secondary gamma rays. In general, the recommended data were based on experimentally measured data. However, where no experimental data were available, the recommended cross sections were obtained using model calculations. (auth) (USGRDR)

37309 (AD-665362) NEUTRON AND GAMMA RAY PRODUCTION CROSS SECTIONS FOR SODIUM, MAGNESIUM, CHLORINE, POTASSIUM, AND CALCIUM. PART IV. CHLORINE. Allen, M. S.; Drake, M. K. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 1967. Contract DA-18-035-AMC-730(A)). 139p. (GA-7829(Pt.4); NDL-TR-89(Pt.4)). CFSTI.

An investigation was made of the neutron interaction probabilities with the element chlorine. Sets of recommended total and partial neutron cross sections were prepared. The energy and angular distributions of the secondary neutrons are given. Also, gamma-ray production cross sections were obtained as well as energy and angular distributions of the secondary gamma rays. In general, the recommended data were based on experimentally measured data. However, where no experimental data were available, the recommended cross sections were obtained using model calculations. (auth) (USGRDR)

37310 (AD-665363) NEUTRON AND GAMMA RAY PRODUCTION CROSS SECTIONS FOR SODIUM, MAGNESIUM, CHLORINE, POTASSIUM, AND CALCIUM. PART V. POTASSIUM. Drake, M. K. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 1967. Contract DA-18-035-AMC-730(A). 133p. (GA-7829(Pt.5); NDL-TR-89(Pt.5)). CFSTI.

An investigation was made of the neutron interaction probabilities with the element potassium. Sets of recommended total and partial neutron cross sections were prepared. The energy and angular distributions of the secondary neutrons are given. Also, gamma-ray production cross sections were obtained as well as energy and angular distributions of the secondary gamma rays. In general, the recommended data were based on experimentally measured data. However, where no experimental data were available, the recommended cross sections were obtained using model calculations. (auth) (USGRDR)

37311 (AD-665364) NEUTRON AND GAMMA RAY PRODUCTION CROSS SECTIONS FOR SODIUM, MAGNESIUM, CHLORINE, POTASSIUM, AND CALCIUM. PART VI. CALCIUM. Drake, M. K. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 1967. Contract DA-18-035-AMC-730(A). 156p. (GA-7829(Pt.6); NDL-TR-89(Pt.6)). CFSTI.

An investigation was made of the neutron interaction probabilities with the element calcium. Sets of recommended total and partial neutron cross sections were prepared. The energy and angular distributions of the secondary neutrons are given. Also, gamma-ray production cross sections were obtained as well as energy and angular distributions of the secondary gamma rays. In general, the recommended data were based on experimentally measured data. However, where no experimental data were available, the recommended cross sections were obtained using model calculations. (auth) (USGRDR)

37312 (ANL-7450, pp 105-7) NUCLEAR CONSTANTS. (Argonne National Lab., Ill.).

The neutron capture cross sections of ^{85}Rb, ^{51}V, and ^{89}Y were measured at neutron energies between 0.1 and 2 MeV using monoenergetic neutrons. Tritium yields from neutron-induced fission of ^{239}Pu, ^{241}Pu, ^{233}U, ^{235}U, and ^{238}U were calculated, as were the rates of He and H production by all neutron-reaction sources in the EBR-II. (D.C.W.)

37313 (ANU-P-405) OPTICAL MODEL AMBIGUITIES FOR ^{22}Ne(^{3}He, ^{3}He)^{22}Ne ELASTIC SCATTERING AT 10 MeV. Bray, K. H.; Nurzynski, J.; Bourke, W. P. (Australian National Univ., Canberra. Research School of Physical Sciences). [1967]. 20p. Dep.

The angular distribution for the elastic scattering of 9.744-MeV ^{3}He particles by ^{22}Ne nuclei was measured from 15 to 160° (lab). An optical model analysis using a central Woods-Saxon potential with volume absorption has indicated a continuous optical potential ambiguity, which appears to be due to the strong dependence of the scattering on the nuclear surface. (auth)

37314 (ANU-P-408) BRANCHING RATIOS OF ^{27}Al BOUND STATES. Elliott, R. V.; Ophel, T. R.; Spear, R. H. (Australian National Univ., Canberra. Research School of Physical Sciences). [1968]. 16p. Dep.

A 12.7 cm × 10.2 cm NaI(Tl) gamma-ray spectrometer was used in conjunction with a 61-cm magnetic particle spectrometer to measure gamma-ray branching ratios for bound states of ^{27}Al at excitation energies of 2.21, 2.73, 2.98, 3.00, 3.68, 3.96, 4.05, 4.41, 4.51, and 4.58 MeV. (auth)

37315 (KFK-704) MEASUREMENTS OF ISOBARIC ANALOGUE STATES IN ^{52}Cr AND ^{60}Ni BY THE HIGH RESOLUTION NEUTRON TIME-OF-FLIGHT METHOD AND BY THE (p,γ) REACTION. Arai, E.; Miessner, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Dec. 1967. 15p. Dep.

The neutron time-of-flight method was used to investigate the cross sections of the reactions ^{59}Co(p,n)^{59}Ni and ^{51}V(p,n)^{51}Cr. The cross sections show a fine structure superimposed on a gross structure; the peaks of the latter are interpreted as analogue states of ^{60}Co and ^{52}V in the compound nuclei ^{60}Ni and ^{52}Cr, respectively. Additional (p,γ) cross-section measurements on ^{59}Co and ^{51}V served as a check and were also used to determine the Coulomb displacement energy. (auth)

37316 (UR-3591-9) NUCLEAR REACTION MECHANISMS. Progress Report, May 1, 1967-May 1, 1968. Blann, Marshall (Rochester Univ., N. Y. Dept. of Chemistry). May 15, 1968 Contract AT(30-1)-3591. 18p. Dep. CFSTI.

The stopping powers of heavy ions in gases were measured; and nuclear level densities of recoil nuclei from α-induced reactions on ^{197}Au, ^{51}V, and ^{90}Zr were investigated. An investigation of (p,d) and (p,t) reactions on ^{117}Sn and ^{119}Sn was initiated. Evidence of spin fractionation in the decay of highly excited compound nuclei was obtained in a study of the reactions ^{58}Ni(α,αpn)^{56}Co, ^{58}Ni(α,αp2n)^{55}Co, and ^{58}Ni(α,3pn)^{56}Co. The search for very neutron-deficient nuclides was continued. A series of experiments on the fusion reactions of heavy nuclei was initiated with a study of ^{32}S reactions with ^{55}Mn. Calculations of the average recoil ranges from deuteron reactions with ^{58}Ni at 20 to 60 MeV were performed. (D.C.W.)

37317 GAMMA EMISSION FROM ^{66}Ga, ^{67}Ga, AND ^{72}Ga. Vrzal, Ya.; Dzhelepov, B. S.; Liptak, Ya.; Moskvin, L. N.; Prikhodtseva, V. P.; Sabirov, B. M.; Tishin, V. G.; Urbanets, Ya.; Tsaritsyana, L. T. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1647-55 (Oct. 1967). (In Russian).

Gamma spectra of ^{66}Ga, ^{67}Ga, and ^{72}Ga were measured using Ge(Li) detectors with sensitivity volumes of ~5 and ~13 cm^3 and a 4-mm thick AC filter. The gallium fraction separated from Ge target 25 hr following the irradiation was used as a source. Tabulated data are given on the energy and relative intensities of ^{66}Ga, ^{67}Ga and ^{72}Ga γ rays, and a decay scheme for ^{66}Ga isotope is included. (R.V.J.)

37318 (α,p) REACTIONS ON NICKEL ISOTOPES AT 19.3 AND 20.1 MeV BOMBARDING ENERGIES. Semenescu, G.; Ivascu, M.; Bucurescu, D.; Titirici, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 185-8(1968).

The angular distributions of some proton groups from the reactions ^{58}Ni(α,p)^{61}Cu, ^{60}Ni(α,p)^{63}Cu, ^{62}Ni(α,p)^{65}Cu, and ^{64}Ni(α,p)^{67}Cu at 19.3 and 20.1 MeV were measured in an attempt to elucidate the dependence of the (α,p) angular distributions on the orbital angular-momentum transfer and the total angular-momentum transfer. Spin-parity assignments were made for states in ^{67}Cu. (D.C.W.)

37319 BETA DECAY OF ^{47}Ca. Multhauf, Lloyd G.; Pratt, William W. (Pennsylvania State Univ., University Park). Nucl. Phys., A114: 476-80(1968).

A delayed-coincidence measurement has shown that beta decay takes place between the ground state of ^{47}Ca and the first excited state of ^{47}Sc with an intensity of 0.11% within an uncertainty of about a factor of two. The resulting log f_1t value for the transition is 9.5 ± 0.3. The strength of this transition, as has been pointed out by previous workers, can be interpreted in terms of core excitation in the ^{47}Ca ground state. (auth)

37320 ELECTROMAGNETIC PROPERTIES OF LOW-LYING LEVELS OF ^{31}Si. Gill, R. D. (Oxford Univ.); Littlewood, G. P.; Lopes, J. S.; Rose, H. J. Nucl. Phys., A114: 416-32(1968).

The decay modes, spins, and mixing ratios of some of the de-excitation gamma rays of the ^{31}Si states located 0.75, 1.69, 2.31, 2.79, 3.14, 3.53, and 4.38 MeV were investigated by an angular correlation technique using the ^{30}Si(d,pγ)^{31}Si reaction. The 1.69-MeV level ($J^\pi = 5/2^+$) decays 100% to ground with $\delta = -4 \pm 1$ or -0.5 ± 0.1. The 2.31-MeV level decays to ground (≈80%) and to the 0.75-MeV state (≈20%). The 2.79-MeV level ($J^\pi = 5/2^+$) decays to the 0.75-MeV level (5%) and to ground (95%) with $\delta = -0.2^{+0.3}_{-0.5}$. The 3.14-MeV level ($J^\pi = 1/2^-$) decays to the 1.69-MeV state (100%) with $\delta = 0.0 \pm 0.1$. The 3.53-MeV level ($J^\pi = 3/2^-$) decays to the 0.75-MeV state (92%) and to ground (8%). The 4.38-MeV state ($J^\pi = 3/2^-$) decays to ground (14%), to the 0.75-MeV state (76%), and to the 1.69-MeV state (10%). The results are discussed in the light of current theoretical models. (auth)

37321 INVESTIGATION OF THE $^{44}Ca(n,\gamma)^{45}Ca$ REACTION. Gruppelaar, H.; Spilling, P.; Spits, A. M. J. (Univ., Utrecht). Nucl. Phys., A114: 463-75(1968).

Gamma rays from thermal-neutron capture in ^{44}Ca were investigated with a 6.5-cm^3 Ge(Li) detector. The uncertainties in the observed γ-ray energies and in the deduced excitation energies are mostly smaller than 1.0 keV. The Q-value for the reaction $^{44}Ca(n,\gamma)^{45}Ca$ was determined as Q = 7414.7 ± 1.0 keV. A decay scheme of ^{45}Ca was constructed. From the γ-decay of ^{45}Ca, together with the results from the (d,p) work, $J^\pi = 3/2^-$ follows for the levels at E_x = 1435, 1900, and 2842 keV. A strong correlation between the (n,γ) and (d,p) strengths was found. (auth)

37322 THE (d,p) AND (d,t) REACTIONS ON ^{38}Ar AND ^{40}Ar. Fitz, W.; Jahr, R.; Santo, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A114: 392-400(1968).

Angular distributions of (d,p) and (d,t) reactions on ^{38}Ar and ^{40}Ar were measured at an incident energy of 11.6 MeV. Some previously unknown L- and J-values were determined. Spectroscopic factors were extracted from a DWBA analysis. Particle-hole configurations in Ar isotopes are discussed and compared to those in the corresponding Ca isotopes. (auth)

37323 OPTICAL-MODEL AMBIGUITIES FOR $^{22}Ne(^3He,^3He)^{22}Ne$ ELASTIC SCATTERING AT 10 MeV. Bray, K. H.; Nurzynski, J.; Bourke, W. P. (Australian National Univ., Canberra). Nucl. Phys., A114: 309-20(1968).

The angular distribution for the elastic scattering of 9.744-MeV ^3He particles by ^{22}Ne nuclei was measured from 15° to 160° (lab). An optical-model analysis, using a central Woods–Saxon potential with volume absorption, indicated a continuous optical-potential ambiguity, which appears to be due to the strong dependence of the scattering on the nuclear surface. (auth)

37324 ENERGY LEVELS OF ^{42}Ti FROM THE $^{40}Ca(^3He,n)$ REACTION. Shapiro, Mark H. (California Inst. of Tech., Pasadena). Nucl. Phys., A114: 401-15(1968).

Using a time-of-flight spectrometer, neutron groups from the $^{40}Ca(^3He,n)^{42}Ti$ reaction were measured at 8.5, 9.0, 9.5, and 10.0 MeV bombarding energy. Groups were measured corresponding to 21 excited states in ^{42}Ti. Close correspondence in excitation energy was observed between the low-lying states of ^{42}Ti reported and analogous states in ^{42}Ca. Angular distributions and relative cross sections were measured for the well-resolved neutron groups. The data are adequately described by simple distorted-wave double-stripping calculations which include spin-orbit coupling in the exit channel. (auth)

37325 PAIRING-MODEL CALCULATION OF NUCLEAR MATRIX ELEMENTS IN THE DECAY OF ^{74}As. Ogata, H.; Habib, E. E. (Univ. of Windsor, Ont.). Phys. Rev., 170: 965-8(June 20, 1968).

The matrix elements $C_A\int\sigma\cdot r$, $C_A\int r$, $C_V\int i\sigma\times r$, and $C_A\int B_{ij}$ are calculated for ^{74}As, using the pairing model. $C_V\int i\alpha$ is determined from the conserved vector current theory, and $C_A\int i\gamma^5$ from β-γ angular correlation data. The ratio of the $(\int B_{ij})^1/(\int B_{ij})^2$ for the β transitions to the ground state and first excited state, respectively, of ^{74}Ge is calculated from these matrix elements and the β intensities. This ratio is also calculated solely from the model and compared with the above ratio to check the internal consistency of the method. The results show that better agreement is obtained if the effect of phonon-quasiparticle coupling is included. (auth)

37326 LIFETIMES OF THE FIRST FOUR EXCITED STATES IN ^{29}Si. Baker, S. I. (Illinois Inst. of Tech., Chicago. Argonne National Lab., Ill.); Segel, R. E. Phys. Rev., 170: 1046-50(June 20, 1968).

The attenuated-Doppler-shift method was used to measure the lifetimes of the first four excited states in ^{29}Si. The states were populated by the $^{28}Si(d,p)$ reaction and the direction of a recoil was defined by the direction of the outgoing proton with which it was in coincidence. The shifts were measured both for the stopping of recoils in a heavy material (gold) and for stopping in a light material (silicon or carbon). The lifetimes of these excited states were found to be 3.1×10^{-13} sec for the first, 3.5×10^{-13} sec for the second, $2.0\pm0.7\times10^{-14}$ sec for the third, and $2.3\pm1.1\times10^{-14}$ sec for the fourth. It is concluded that no simple picture adequately describes the low-lying states in ^{29}Si, but that a mixture of two rotational bands shows promise. (auth)

37327 ISOBARIC-ANALOG RESONANCES IN Se ISOTOPES. Balamuth, D. P.; Couchell, G. P.; Mitchell, G. E. (Columbia Univ., New York). Phys. Rev., 170: 995-1002(June 20, 1968).

Isobaric-analog resonances were observed by measuring excitation curves for (p,p) elastic scattering from ^{76}Se, ^{78}Se, ^{80}Se, and ^{82}Se. Excitation curves were also measured for the (p,n) reaction on ^{78}Se, ^{80}Se, and ^{82}Se. All resonances observed in elastic scattering were fitted using a Coulomb-plus-single-level formula, and l values and resonance parameters were extracted. The level positions and l values agree quite well with a recent (d,p) study of the selenium isotopes, except for one case where two isobaric-analog resonances were reported as a single state in the (d,p) work. Coulomb energy differences were computed for the four pairs of nuclei (^{77}Se,^{77}Br), (^{79}Se,^{79}Br), (^{81}Se,^{81}Br), and (^{83}Se,^{83}Br). Spectroscopic factors were also calculated for all resonances observed in elastic scattering; these are compared with the spectroscopic factors extracted from the stripping data. (auth)

37328 $^{46}Ca(p,d)^{47}Ca$ AND $^{48}Ca(p,t)^{46}Ca$ REACTIONS. Peterson, R. J. (Princeton Univ., N. J.). Phys. Rev., 170: 1003-13 (June 20, 1968). (PUC–937-276).

This study of the $^{46}Ca(p,d)^{47}Ca$ reaction at a bombarding energy of 18 MeV finds evidence for a small admixture of neutrons from the 2p orbitals in the ground state of ^{46}Ca. The summed spectroscopic factor for 2p pickup is 0.36. If the mixing is of zero-coupled pairs of $2p_{\frac{3}{2}}$ neutrons, the coefficient of this admixed term in the wave function is 0.42. The positions and spectroscopic factors for several states that appear to be due to d-wave or f-wave pickup are also given, and two apparent examples of j dependence are used to make spin assignments of $5/2^-$ in ^{47}Ca. Angular distributions of tritons from the $^{48}Ca(p,t)^{46}Ca$ reaction are shown for seven states of ^{46}Ca, but reliable spin determinations cannot be made, owing to the lack of structure in the observed distributions. (auth)

37329 ANALYSIS OF THE LOW-LYING LEVEL STRUCTURE OF ^{31}Si. Webb, V. H. (Duke Univ., Durham, N. C.); Roberson, N. R.; Tilley, D. R. Phys. Rev., 170: 989-94 (June 20, 1968).

The strong-coupling collective model was applied to the low-lying level structure of ^{31}Si. Two rotational bands are identified corresponding to the Nilsson orbits 8 (K = 3/2) and 9 (K = 1/2), with the ground and first excited (760-keV) levels being the respective bandheads. Detailed comparisons are made concerning the properties of the low-lying levels, such as spectroscopic factors for neutron capture, γ-ray multipole mixing ratios, the γ-ray branching ratio for the 1.70-MeV level, and the log ft value for β decay. The results indicate that ^{31}Si is an oblate spheroid with a deformation on the order of $\eta\approx-2.0$. With the parameters $\kappa\approx0.10$, $g_R\approx0.32$, and $\mu\approx0.2$, the model is found to give reasonable results for many of the above properties. In particular, the model is found to predict the anomalously high T(E2)/T(M1) multipole intensity ratio observed for the 1.70 → 0-MeV γ-ray transition. (auth)

37330 CONVERSION COEFFICIENTS OF THE ^{57}Fe 14.4-keV TRANSITION, THE K-CAPTURE FRACTION IN ^{57}Co e^- CAPTURE, AND THE K-FLUORESCENCE YIELD OF Fe. Rubinson, William; Gopinathan, K. P. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 170: 969-78(June 20, 1968). (BNL–12089).

By x-x and x-γ coincidence-counting of a $^{57}Co\rightarrow{}^{57}Fe$ source with gas proportional counters, the values $\alpha_K\omega_K = 2.484$ (±1.8%), $f\omega_K = 0.3044$ (±1.4%), and $S/(\alpha_T+1) = 0.09482$ (±2.3%) are obtained, where α_K and α_T are the K and total conversion coefficients of the ^{57}Fe 14.4-keV γ ray, ω_K is the K-fluorescence yield of Fe, S is the probability that the ^{57}Fe 136.4-keV level decays to the 14.4-keV level, and f is the fraction of K captures in ^{57}Co e^- capture. These numbers are consistent within narrow limits with others reported precise measurements of S, f, and the ratio α_K/α_T. With the use of the values S = 0.87 (±1.7%) and $\alpha_K/\alpha_T = 0.89$ (±0.15%) from electron-spectrometer measurements reported by others, we obtain $\alpha_T = 8.17$ (±3.1%); $\alpha_K = 7.27$ (±3.1%); f = 0.891 (±3.85%); $\omega_K = 0.342$ (±3.6%). The value of α_T is 9% lower than that reported for some half-dozen measurements by γ-γ coincidence counting and by Moessbauer methods, all of which cluster closely about the value 9.0. It closely confirms the theoretical α_T. The f value agrees closely with one measured by multiwire proportional counter, and our ω_K agrees with a recent direct measurement. (auth)

37331 EXPERIMENTAL STUDY OF THE LOW-LYING LEVELS OF ^{31}Si. Webb, V. H. (Duke Univ., Durham, N. C.); Roberson, N. R.; Poore, R. V.; Tilley, D. R. Phys. Rev., 170: 979-89(June 20, 1968).

The 0.76-, 1.70-, 2.32-, 2.79-, and 3.54-MeV levels of ^{31}Si were studied using a collinear geometry with the observed particles being detected in an annular solid-state counter placed at 180° relative to the beam direction. The above levels were populated by the $^{30}Si(d,p)^{31}Si$ reaction with deuteron energies of 3.01 and 3.22 MeV. γ radiation was detected by a 7.62 × 7.62-cm NaI crystal at five angles between 26° and 90° relative to the beam direction. From the analysis of the experimental correlations, spin determinations of 1/2, 3/2, 1/2, and 3/2 were established for the 1.70-, 2.32-, 3.14-, and 3.54-MeV levels, respectively. An isotropic correlation was measured for the level at 760 keV, in agreement with the known spin of 1/2 for this level. The analysis

for the 2.79-MeV level agrees with the spin value of $\frac{5}{2}$ which is indicated from the shape of the $l_n = 2$ angular distribution from the $^{30}Si(d,p)$ reaction corresponding to population of this level. In addition, information on the γ-ray multipole mixing ratios and γ-ray branching ratios for many of the above levels was determined. (auth)

37332 NUCLEAR-STRUCTURE STUDIES OF THE CHROMIUM ISOTOPES: THE $^{50}Cr(p,p')^{50}Cr$ AND $^{50}Cr(d,p)^{51}Cr$ REACTIONS. Robertshaw, J. E. (Providence Coll.); Mecca, S.; Sperduto, A.; Buechner, W. W. Contract AT(30-1)-2098. Phys. Rev., 170: 1013-33(June 20, 1968). (MIT-2098-418).

The $^{50}Cr(p,p')^{50}Cr$ and $^{50}Cr(d,p)^{51}Cr$ reactions were studied using 7.5-MeV protons and deuterons from the MIT-ONR electrostatic generator and the MIT multiple-gap spectrograph to analyze the reaction protons. Fifteen levels in ^{50}Cr up to an excitation energy of 3.929 MeV and 156 levels in ^{51}Cr up to an excitation energy of 7.931 MeV were observed. The ground-state Q value for the (d,p) reaction was measured as 7.041 ± 0.006 MeV. A zero-range, distorted-wave Born-approximation (DWBA) analysis was used to obtain values for the orbital angular momentum of the transferred neutrons and transition strengths for 52 levels. Three optical-model potentials for the deuteron were used in the DWBA analysis, each giving satisfactory fits to both elastic scattering and (d,p) data. The results are compared with shell-model, sum-rule limits, and with the level structure of other N = 27 nuclei (^{47}Ca and ^{49}Ti). (auth)

37333 LEVEL STRUCTURFS OF ^{59}Cu AND ^{61}Cu STUDIED BY MEANS OF THE $^{58,60}Ni(^3He,d)$ REACTIONS. Pullen, D. J.; Rosner, Baruch (Univ. of Pennsylvania). Phys. Rev., 170: 1034-40(June 20, 1968).

The reactions $^{58,60}Ni(^3He,d)^{59,61}Cu$ were studied at 16.4-MeV incident energy. Forty-two states up to 7.1-MeV excitation were observed in ^{59}Cu, and 82 states up to 8.5 MeV were observed in ^{61}Cu. Deuteron angular distributions were recorded in the angular interval 7 to 60° and, with the aid of distorted-wave analysis, spectroscopic information was obtained for those states which are fed by the more intense transitions. The low-lying level structures are compared with the unified-model predictions. (auth)

37334 ANGULAR DISTRIBUTION OF ^{64}Cu NUCLEI FROM THE $^{65}Cu(^3He,\alpha)$ REACTION. Porile, N. T. (Purdue Univ., Lafayette, Ind.); Fujiwara, I.; Hahn, R. L. Phys. Rev., 170: 958-65(June 20, 1968). (COO-1505-23).

The angular distribution of ^{64}Cu nuclei produced in the interaction of ^3He ions with ^{65}Cu was measured over the energy range 12 to 32 MeV. The results were compared with a distorted-wave calculation for the $(^3He,\alpha)$ pickup process and with a statistical-theory calculation for the evaporation process. It is found that contributions from both mechanisms are required to reproduce the data. The compound-nuclear process, which involves the evaporation of an α particle at the lower energies and of four nucleons at the higher ones, accounts for most of the ^{64}Cu yield at small angles to the beam, whereas the pickup process accounts for most of it at large angles. (auth)

37335 EVAPORATION OF ^8Li NUCLEI IN THE INTERACTIONS OF K^- MESONS AT 10.1 GeV/c WITH NUCLEI OF SILVER AND BROMINE. Baumann, Germain (Faculte des Sciences, Nancy); Gerber, Jean-Paul; Bechdolff, Alfred; Jousset, Jacques, Montret, Michele. Compt. Rend., Ser. A and B, 266: 1046-8 (Apr. 8, 1968). (In French).

The production rate of ^8Li nuclei was determined as 1.17 ± 0.07%. The emission of ^8Li nuclei can be explained by the evaporation theory with the existence of a local hot point. (tr-auth)

37336 DECAY OF ^{50}Ca. Chase, L. F. Jr.; McDonald, R. E.; Nightingale, R. W. (Lockheed Palo Alto Research Lab., Calif.). Phys. Rev. Lett., 21: 33-6(July 1, 1968).

The decay of ^{50}Ca was reinvestigated. The serious discrepancy was between various theoretical calculations of ^{50}Sc and earlier experimental results was resolved by the observation of an allowed ^{50}Ca β decay to the 1848-keV level in ^{50}Sc. The $J^\pi = 1^+$ assignment for this state and its γ-ray branching ratio are in good agreement with the recent theoretical treatment of ^{50}Sc by Hughes and Soga. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 35879, 37090, 37277, 37281, 37312, 37316, 37335, and 37393.

37337 (AD-801007) DELAYED GAMMA RAYS FROM FISSION. Technical Report, August 1, 1965–July 31, 1966. Walton, R. B.; Sund, R. E. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 1966. Contract AF29(601)-6837. 60p. (GA-7348; AFWL-TR-66-122). CFSTI.

Measurements of the energy spectrum of delayed gamma rays from the neutron fission of ^{239}Pu and ^{238}U were performed with a NaI detector at a number of time intervals between 2 and 80 microsec. The data showed three new prominent gamma rays with energies of 205, 390, and 1330 keV; two unresolved gamma rays having energies of approximately 110 keV; and the six gamma rays which were observed in previous studies for T > 50 microsec after fission. Absolute intensities of the new gamma rays were obtained using the normalization factor derived from the relative intensities of the last six gamma rays and their previously determined absolute intensities. (auth) (USGRDR)

37338 (COO-1505-26) DEEXCITATION PROCESSES IN HIGH-ENERGY NUCLEAR REACTIONS. Progress Report for the Period May 1967–April 1968. Porile, Norbert T. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). May 1968. Contract AT(11-1)-1505. 29p. Dep. CFSTI.

The charge distribution and the product recoil properties in the fission of ^{208}Pb and ^{238}U by 12-GeV protons were investigated, as was the energy dependence of the recoil properties of fission products in proton-induced fission of ^{238}U at very high energies. The differential ranges of the products of the reactions $^{63}Cu(\alpha,n)$, $^{65}Cu(\alpha,2n)$, and $^{65}Cu(\alpha,3n)$ were measured up to a bombarding energy of 40 MeV. The ^{66}Ga recoil angular distribution and the neutron spectrum from the $^{63}Cu(\alpha,n)$ reaction were calculated using spin-dependent statistical theory. Recoil ranges and isomer ratios for the reactions $^{116}Cd(He\text{-}3,\alpha)$ and $^{116}Cd(\alpha,\alpha n)$ were measured. Average projected recoil ranges from the reaction $^{12}C(p,pn)$ at 40 to 150 MeV were also obtained. (D.C.W.)

37339 (COO-1746-6) THE DETERMINATION OF G-FACTORS OF SHORT LIVED EXCITED STATES USING MAGNETIC SOURCES. Steffen, R. M. (Purdue Univ., Lafayette, Ind. Dept. of Physics). July 1968. Contract AT(11-1)-1746. 2p. (CONF-680702-3). Dep. CFSTI.

From International Symposium on Nuclear Structure, Dubna, USSR.

The measurement of the g-factors of nuclear excited states by the observation of the Larmor precession, ω, of the excited states in the magnetic fields that act on the nuclei of atoms embedded in ferromagnetic lattices was investigated. Values of $\omega\tau$, where τ is the lifetime of the excited state, were measured for several excited states in ^{160}Dy, ^{152}Gd, ^{177}Hf, ^{208}Pb, ^{190}Os, ^{192}Os, ^{192}Pt, ^{152}Sm, and ^{169}Tm using Ge(Li) detectors to observe the rotation of the γ-γ directional correlations from magnetic sources that were polarized by an applied field of about 1000 gauss. (D.C.W.)

37340 (EANDC(E)-89U) PROGRESS REPORT ON NUCLEAR DATA RESEARCH IN THE EURATOM COMMUNITY, JANUARY 1–DECEMBER 31, 1967. (European-American Nuclear Data Committee. European-American Committee on Reactor Physics). Feb. 1968. 239p. Dep.

Research activities and programs in the EURATOM community during the period Jan. 1 to Dec. 31, 1967, are summarized. Neutron cross section measurement programs comprise the bulk of the material included. (D.C.W.)

37341 (IN-1132) NEUTRON TOTAL AND ABSORPTION CROSS SECTIONS OF ^{242}Pu. Young, T. E.; Reeder, S. D. (Idaho Nuclear Corp., Idaho Falls). June 1968. Contract AT(10-1)-1230. 85p. Dep. CFSTI.

The total neutron cross section of ^{242}Pu was measured from 0.008 to 8000 eV using PuO_2 powder samples in the Materials Testing Reactor (MTR) fast chopper. The data were analyzed to give the thermal absorption cross section and resonance parameters below 180 eV. The observed total neutron cross section at 0.0253 eV is 39 ± 1 b, and the effective (equivalent 1/v) thermal absorption cross section derived from the measurement is 22 ± 2b. Parameters of individual resonances below 180 eV and average parameters at higher energies give a resonance absorption integral of 1090 ± 60 b and a neutron s-wave strength function $(\bar{\Gamma}_n^0/D)$ of $(0.85 \pm 0.10)10^{-4}(eV)^{-\frac{1}{2}}$. (auth)

37342 (ITEF-546) POLNOE NEITRONNOE SECHENIE TORIYA-230 V TEPLOVOI OBLASTI ENERGII. (The Total Neutron Cross Section of ^{230}Th at the Thermal Energy Region). Kalebin, S. M.; Palei, P. N.; Ivanov, R. N.; Karalova, Z. K.; Kukavadze, G. M.; Pyzhova, Z. I.; Rukolaine, G. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 14p. (In Russian). Dep.

One gram of the purified ^{230}Th was chemically educed from uranic ore. The purity of the sample prepared was established by means of a mass-spectrometric analysis. Neutron cross sections were measured on the ITEP chopper at 0.0141 to 1.0 eV.

As a result of the measurement, it was shown that the neutron cross section of ^{230}Th in the thermal region has neutron resonance levels close to the thermal energy. In particular, it is shown that there exists a negative level with energy close to zero. At the thermal point (E = 0.025 eV), the total cross section of ^{230}Th is 70 ± 3.8 barn. It is also shown that when measuring with new samples of $^{230}_{90}$Th in the wider energy region, the levels with the energies E = 1.107, 2.390, and 7.80 eV were not obtained. The results of measurements of the total neutron cross section of $^{230}_{90}$Th in thermal energy region require more careful analysis of the experimental data which were published for the neutron cross section of $^{230}_{90}$Th in that energy region. (auth)

37343 (ITEF-X-529) REZONANSNOE RASSEYANIE GAMMA-LUCHEI ^{191}Ir S ENERGIEI 129 keV. (Resonance Scattering of Gamma Rays of ^{191}Ir with Energy of 129 keV). Davydov, A. V.; Kartashov, G. R.; Khrudev, Yu. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 24p. (In Russian). Dep.

The angular distribution of 129-keV gamma rays resonantly scattered by ^{191}Ir nuclei (Moessbauer effect) was measured. These data were used in determining the magnetic moment of the ^{191}Ir excited state with the energy of 129 keV. The experiment consisted in the measurement of the rotation angle of the scattered radiation angular distribution in the magnetic field of ±24.5 kOe. The measured value of the magnetic moment was 3.00 ± 0.58 nm. At the same time the multipole mixing parameter was determined for the 129-keV transition to be δ = +0.398 ± 0.20. (auth)

37344 (JINR-P6-3823) NOVYI IZOTOP ^{136}Nd I PRODUKTY EGO RASPADA. (New ^{136}Nd Isotope and its Decay Products). Zhelev, Zh.; Kalinnikov, V. G.; Liptak, Ya.; Peker, L. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 21p. (In Russian). Dep.

The previously unknown isotope ^{136}Nd ($T_{½}$ = 55 ± 1.5 min) was identified. The positron, γ-ray, and conversion electron spectra of the decay chain of ^{136}Nd → ^{136}Pr → ^{136}Ce were investigated. The multipolarities of a number of transitions were determined. The scheme of the ^{136}Pr and ^{136}Ce excited levels is suggested. The characteristics 1^+ are ascribed to the 108.8-keV ^{136}Pr level, while the characteristics 2^+ are ascribed to the ground state ($T_{½}$ = 13.5 min). The ^{136}Ce levels with the energies 551.5, and 1090.4 keV have characteristics 2^+ while those of the 1551.3-keV level are $I^π = 3^+$. Possible quantum characteristics and other ^{136}Ce levels are estimated by comparing the spectra of even-even states containing 78 neutrons. (auth)

37345 (N-68-21924) APPLICATIONS OF MONTE CARLO ANALYSIS TO TUNGSTEN RESONANCE ABSORPTION. Westfall, Robert M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1968. 47p. (NASA-TN-D-4545). CFSTI.

Calculational procedures for Monte Carlo analyses of tungsten resonance absorption are presented. The widely used flat spatial neutron source assumption is shown to overestimate the effective resonance integral of the large scattering resonance in ^{186}W by 21% at a surface-to-mass ratio (S/M) of 0.5 cm^2/g. Resonance overlap in natural W decreases the effective resonance integral by 18 to 7% over a S/M range of 0.16 to 4.0 cm^2/g relative to calculations which ignore resonance overlap. Spatial self-shielding in a complex geometric cell is evaluated through comparison of Monte Carlo calculations with exact geometric and homogenized absorber region representations. The code EPIGRAM, which selects energy points for resonance cross sections, is reported. (auth) (STAR)

37346 THE ELASTIC SCATTERING OF ^{60}Co GAMMA RAYS FROM LEAD. Dixon, W. R.; Storey, R. S. (National Research Council of Canada, Ottawa). Can. J. Phys., 46: 1153-62(May 15, 1968).

The elastic scattering of ^{60}Co gamma rays from lead was remeasured using a lithium-drifted germanium detector. For angles less than 90°, there is satisfactory agreement between the measured and calculated values. For angles greater than 90°, the measured values are significantly smaller. The discrepancy is too large to be attributed to destructive interference from Delbrück scattering. An explanation can be found in the possibility that there are phase shifts between the Rayleigh and nuclear Thomson components. (auth) (Canada)

37347 SOME REMARKS ON THE EXCITATION FUNCTION OF THE ^{241}Am(n,γ)$^{242\,mf}$Am REACTION. Boca, I. (Inst. of Atomic Physics, Bucharest); Martalogu, N.; Sezon, M.; Vilcov, I.; Vilcov, N.; Flerov, G. N.; Pleve, A. A.; Polikanov, S. M.; Tretyakova, S. P. Rev. Roum. Phys., 13: 181-3(1968).

The neutron spectrum from the reaction ^{7}Li(p,n)^{7}Be at mean proton energies of 8.3 to 9.1 MeV was measured in order to determine the contribution of soft neutrons to the spectrum. It was found that the excitation function of the reaction ^{241}Am(n,γ)$^{242\,mf}$Am cannot be measured accurately in the neutron energy range from 6 to 7 MeV using the reaction ^{7}Li(p,n)^{7}Be as a neutron source. (D.C.W.)

37348 DECAY OF 35 min ^{111}Sn TO LEVELS OF ^{111}In. Graeffe, G.; Gordon, G. E. (Massachusetts Inst. of Tech, Cambridge). Contract AT(30-1)905. Nucl. Phys., A114: 321-9(1968). (MIT-905-115).

The EC/$β^+$ and γ-decay of 35 min ^{111}Sn to levels of ^{111}In was studied with Ge(Li) and NaI(Tl) detectors. A total of 16 γ-rays between 373 and 2325 keV are definitely assigned to the decay scheme. Excited states of ^{111}In are established at 536 (^{111m}In), 1101, 1153, 1610, 1915, 2107, 2178, 2213, and 2325 keV. The isomer 7.3-min ^{111m}In is produced in 0.09% of the ^{111}Sn decays. The spin-parity assignment of ^{111}Sn is $9/2^+$ and those of ^{111}In and ^{111m}In are $9/2^+$ and $1/2^-$, respectively. The EC transitions to all of the observed higher levels of ^{111}In, except possibly the one at 1543 keV are allowed, leading to assignments of $5/2$, $7/2$, or $9/2^+$ for those levels. No evidence was obtained for any transitions to $1/2^+$ or $3/2^+$ levels similar to those in ^{115}In and ^{117}In that have been suggested as the lowest members of a rotational band. (auth)

37349 THE EXCITED STATES OF ^{193}Ir POPULATED BY THE BETA DECAY OF ^{193}Os. Avida, R.; Burde, J.; Molchadzki, A.; Berant, Z. (Hebrew Univ., Jerusalem). Nucl. Phys., A114: 365-76(1968).

Gamma-gamma coincidence measurements were used to establish the decay level scheme of ^{193}Ir, which is populated by the beta decay of ^{193}Os. Angular correlation measurements were carried out for seven cascades utilizing a Ge(Li) detector and a NaI(Tl) scintillator. A comparison between the gamma singles spectra and the electron conversion lines yielded the conversion coefficients for the most prominent transitions. From these angular correlation measurements and the conversion coefficient results, the spin assignment for the 180, 361, and 712 keV states was determined as $3/2^+$. The most prominent transitions were found to be predominantly M1 with a small E2 admixture. The sequence of levels in ^{193}Ir and their mode of de-excitation were found to resemble very closely those of ^{197}Au. (auth)

37350 DECAY OF ^{200}Au (48 min). Schult, O. W. B.; Kane, W. R.; der Mateosian, E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 170: 1055-8(June 20, 1968).

Gamma radiation from the decay of ^{200}Au was measured in the energy range from 0.2 to 2 MeV with a 30-cm^3 coaxial-type lithium-drifted germanium detector. Fifteen γ rays attributable to ^{200}Hg were observed. Levels at 1570, 1593, and 1631 keV in ^{200}Hg are strongly populated via $β$ decay. Weak feeding is suggested for levels at 1718, 1883, 1972, and 2061 keV. The $β$ branch to the 2^+ level at 368 keV was found to be <8%; and the $β$ branches to the 4^+ level at 947 keV, to the 0^+ level at 1029 keV, and to the 2^+ level at 1254 keV were found to be <0.2%, <0.5%, and <0.2%, respectively. The results favor spin and parity 1^- for the ground state of ^{200}Au. Instead of a single 1225-keV line reported in the literature, a doublet with an energy difference of 37 keV was found. Also, instead of a single 1.6-MeV γ ray known from scintillation spectrometer work, a group of γ rays with energies between 1.5 and 1.7 MeV was observed. (auth)

37351 COULOMB EXCITATION OF THE LOWEST STATES IN TUNGSTEN NUCLEI. Stokstad, R. G.; Persson, B. (California Inst. of Tech., Pasadena). Contracts AT(04-3)-63; Nonr-220(47). Phys. Rev., 170: 1072-5(June 20, 1968).

The following reduced transition probabilities for tungsten isotopes were determined in Coulomb-excitation experiments by the study of inelastically scattered $α$ particles: $B(E2, 0^+ \rightarrow 2^+)/e^2b^2 = 4.30 \pm 0.08$, 3.84 ± 0.07, and 3.50 ± 0.06 for ^{182,184,186}W, respectively, and $B(E2, 1/2^- \rightarrow 5/2^-)/e^2b^2 = 2.31 \pm 0.11$ and $B(E2, 1/2^- \rightarrow 3/2^-)/e^2b^2 = 1.50^{+0.15}_{-0.10}$ for ^{183}W. The ratios of the transition matrix elements derived from these quantities are compared, for the even isotopes, with the corresponding ratios of quadrupole moments determined in Moessbauer experiments. These ratios are equal within 2.2 ± 2.2%, and therefore agree with the prediction of the rotational model. Microscopic calculations by Kumar and Baranger predict somewhat larger differences among the ratios than those determined in the present work. (auth)

37352 NUCLEAR SPINS AND MOMENTS OF THE 86.5- AND 105.3-keV STATES IN ^{155}Gd. Blumberg, H.; Persson, B.; Bent, M. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Rev., 170: 1076-82(June 20, 1968).

The recoilless nuclear resonance absorption of the γ rays from the 86.5- and 105.3-keV states in ^{155}Gd was studied to determine the spins, the quadrupole moments, and magnetic moments of these states. The following quantities were determined: $I(105.3) = 3/2$, $|Q(86.5)/Q(0)| = 0.20 \pm 0.10$, $0.80 < Q(105.3)/Q(0) \lesssim 1.00$,

$\mu(86.5) = -0.53 \pm 0.05\ \mu_N$, and $\mu(105.3) = 0.13 \pm 0.04\ \mu_N$ or $-0.38 \pm 0.06\ \mu_N$. The results imply strong band mixing in the 86.5-keV state and $I(86.5) = 3/2$. (auth)

37353 COULOMB EXCITATION OF THE EVEN TIN NUCLEI. Stelson, P. H.; McGowan, F. K.; Robinson, R. L.; Milner, W. T.; Sayer, R. O. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 170: 1172-4(June 20, 1968). (ORNL-P-3626).

Coulomb excitation of the first 2^+ states of the even tin nuclei was produced by 10-MeV α particles to obtain accurate B(E2) values (relative error ±2%, absolute error ±5%). The experimental B(E2) values are compared with the values calculated by Kisslinger and Sorensen and by Uher and Sorensen. The Uher–Sorensen B(E2)'s are in appreciably better agreement with the experimental results than are the Kisslinger–Sorensen ones. (auth)

37354 TRANSITIONAL NUCLEI. I. DECAY OF ^{154}Eu TO LEVELS OF ^{154}Sm AND ^{154}Gd. Meyer, R. A. (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 170: 1089-1108(June 20, 1968). (UCRL-70766).

The γ-ray spectra accompanying the decay of ^{154}Eu (16 yr) were studied by using an isotopically separated ^{154}Eu source as well as a Ge(Li) Compton suppression spectrometer. Over 150 γ rays have been detected and can be ascribed to 32 different levels. It is suggested that the positive-parity levels can be accounted for by assignment to one- and two-phonon vibrational bands, and that the negative-parity levels form the bands of the fragmented octupole state. The level structure of the K = 0 and 1 members can be accounted for by assuming a strong Coriolis coupling between them. The relative E2 transition probabilities from the one- and two-phonon bands can not be reconciled with simple two-band mixing theory. Properties associated with z_K indicate that z_K is not a good quantity in this nucleus, because of the strong mixing of the β- and γ-vibrational bands, and that its use in the past may have given false results for properties associated with it. Other levels are at 1277.6, (1415.6), 1645.93, 1770.3, 1838, and 1894.69. The K = 2 octupole state is consistent with Solov'ev and co-workers' assignment of a nearly pure two-quasiparticle configuration of [411] $[523]_p$, while the K = 1 state is more consistent with its being of nearly pure [411] $[523]_p$ two-quasiparticle configuration. Consideration is given to a rotation-vibration Coriolis-type interaction between the K = 0 and 1 bands and a proposed pseudo-rotor-particle-coupling Coriolis-type interaction between the K = 1 and 2 bands of the octuple state. It is suggested that the levels at 1531.39, 1660.94, and 1790.4 keV form a $\beta\gamma$-coupled second vibrational band. (auth)

37355 NUCLEAR LEVELS OF ^{169}Yb POPULATED IN THE ^{168}Yb(n,γ) REACTION. Shera, E. B. (Los Alamos Scientific Lab., N. Mex.); Bunker, M. E.; Sheline, R. K.; Vegors, S. H. Jr. Phys. Rev., 170: 1108-18(June 20, 1968). (LA-DC-9210).

The level structure of ^{169}Yb was studied using the thermal-neutron capture reaction ^{168}Yb(n,γ)^{169}Yb. The γ-ray spectrum from this reaction was studied in the energy intervals 60 to 1500 keV and 5200 to 7000 keV with Si(Li) and Ge(Li) spectrometer systems. Targets of isotopically separated ^{168}Yb and ^{174}Yb and of natural ytterbium were used to provide definitive identification of transitions occurring in ^{169}Yb. The results of this investigation are compared with the published results from studies of the (d,p) and (d,t) reactions, radioactive decay, and the neutron-capture internal-conversion electron spectrum. The levels observed in the (n,γ) studies include: the $7/2^+$ and $9/2^+$ members of the [633↑] ground-state rotational band; the 5 lowest members of the [521↓] band, based at 24.3 keV; the $5/2^-$, $7/2^-$, and $9/2^-$ members of the [512↑] band, based at 191.2 keV; the $5/2^-$ and $7/2^-$ members of the [523↓] band, based at 569.8 keV; the two lowest members of the [521↑] band, based at 659.8 keV; the $3/2^+$ and $5/2^+$ members of a $K^\pi = 3/2^+$ band, based at 720.0 keV, believed to be partly vibrational and partly [651↑]; and the 4 lowest members of a $K^\pi = 1/2^-$ band, based at 813.2 keV, believed to involve large components of both [510↑] and the vibrational configuration $[512\uparrow]_{\gamma\text{-vib}}$. In addition, specific configurational assignments are proposed for several of the levels observed above 850 keV. Details of the level structure are discussed in the light of recent theoretical calculations by Soloviev et al. and by Bés and Cho. Emphasis is placed on the possible structure of the previously unobserved 720.0-keV $3/2^+$ band, and Coriolis calculations involving this band are presented. (auth)

37356 ANALYSIS OF THE NUCLEAR REACTION SPECTROSCOPY OF ^{177}Hf, ^{179}Hg, AND ^{181}Hf. Rickey, F. A. Jr.; Sheline, R. K. (Florida State Univ., Tallahassee). Phys. Rev., 170: 1157-71(June 20, 1968).

This study of the nuclear levels in ^{181}Hf, ^{179}Hf, and ^{177}Hf has utilized the reactions ^{180}Hf(d,p)^{181}Hf, ^{180}Hf(d,t)^{179}Hf, ^{178}Hf(d,t)^{177}Hf, and ^{176}Hf(d,p)^{177}Hf at incident deuteron energies of 10 to 12 MeV. The emergent particles were analyzed in a broad-range magnetic spectrograph. The ground-state Q-values were determined to be ^{180}Hf(d,p), Q = 3475 ± 10 keV; ^{180}Hf(d,t), Q = −1112 ± 4 keV; ^{178}Hf(d,t), Q = −1364 ± 9 keV; and ^{176}Hf(d,p), Q = 4150 ± 7 keV. Angular distributions were measured for the reactions ^{180}Hf(d,p)^{181}Hf, ^{178}Hf(d,t)^{177}Hf, and ^{176}Hf(d,p)^{177}Hf, and interpreted with the aid of the distorted-wave Born approximation theory. l values have been assigned and spectroscopic factors extracted. The assignment of l values has resulted in the interpretation of the structure of ^{181}Hf and ^{177}Hf up to 2 MeV. The (d,t) study of ^{179}Hf has been used in conjunction with previously reported (d,p) data, and has resulted in an extension of the previous analysis. Nilsson states identified in one or more nuclei are the $7/2^+$[633], $1/2^-$[521], $5/2^-$[512], $7/2^-$[514], $9/2^+$[624], $1/2^-$[510], $3/2^-$[512], $7/2^-$[503], $3/2^-$[501], $5/2^-$[503], and $13/2^+$[606]. In addition a large number of K = 1/2 and 3/2 bands have been observed which do not have a simple interpretation in the Nilsson theory. While the low-lying (predominantly Nilsson) states agree quite well with the calculations of Soloviev, the higher states do not. (auth)

37357 NUCLEAR ORIENTATION OF ^{124}Sb. Knott, T. F.; Andrews, H. R.; Greenebaum, B.; Pipkin, F. M. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 170: 1051-4(June 20, 1968).

The magnetic moment of ^{124}Sb was found to be $\pm 1.26 \pm 0.07\ \mu_N$ by observing the anisotropy of the 1691-keV γ ray following the decay of oriented antimony nuclei. The results obtained from sources prepared by ion bombardment are in good agreement with those from a source prepared by diffusion. The observed anisotropy of the 2091-keV γ ray is consistent with a pure Gamow-Teller β feed and an E1 γ transition. (auth)

37358 NUCLEAR MOMENTS OF ^{157}Tb, ^{158}Tb, AND ^{160}Tb BY ELECTRON PARAMAGNETIC RESONANCE AND NUCLEAR ALIGNMENT. Easley, Warren C.; Barclay, J. A.; Shirley, D. A. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 170: 1083-8(June 20, 1968). (UCRL-17578).

Electron-paramagnetic-resonance experiments on yttrium ethylsulfate (YES) single crystals containing terbium isotopes in the relative abundances ^{159}Tb : ^{157}Tb : ^{158}Tb = 25 : 1.6 : 1 were carried out at Q-band frequencies (35 GHz). The nuclear spin of ^{158}Tb was found to be 3, and by comparison with the observed hyperfine structure of ^{159}Tb and its known moment, a magnetic moment $\mu^{158} = 1.740(7)$ nm was calculated. Transitions due to ^{157}Tb were obscured by the stronger ^{159}Tb lines. Assuming $I(157) = I(159) = 3/2$, the following limits were set on the value of $\mu^{157} : \mu^{157} = 2.0(1)$ nm. ^{160}Tb lines were also observed in YES single crystals. They gave $\mu^{160} = 1.685(8)$ nm. Nuclear-alignment experiments on ^{158}Tb in a single crystal of neodymium ethylsulfate were also carried out in order to determine a relation between the quadrupole coupling constant and the magnetic hyperfine structure constant. This information, as well as existing nuclear-orientation results on ^{160}Tb, was combined with the EPR data to obtain quadrupole coupling constants. Quadrupole moments calculated from the coupling constants were found to be $Q^{158} = +2.7(5)$ b and $Q^{160} = +3.0(5)$ b. (auth)

37359 ANGULAR CORRELATIONS IN THE (d,pf) REACTION. Wolf, K. L.; Vandenbosch, R.; Loveland, W. D. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Phys. Rev., 170: 1059-65(June 20, 1968). (RLO-1388-51).

Angular correlations, both in and out of the (d,p) reaction plane, were measured for the ^{239}Pu(d,pf) reaction. The observed correlations are strongly dependent on the angle of emission of the protons. For protons emitted in the backward direction, the out-of-plane correlations are isotropic and the in-plane correlations are large. For protons emitted in the forward direction, significant out-of-plane correlations are observed, and the in-plane correlations are reduced. The character of the out-of-plane correlation shows that the (d,p) reaction produces nuclei which on the average have a larger component of angular momentum about an axis perpendicular to the beam-proton plane than parallel to that plane. The qualitative features of the results are interpreted in terms of a simple classical model. More detailed comparisons are made with a theoretical description based on the distorted-wave Born approximation. (auth)

37360 INELASTIC SCATTERING OF 20-MeV TRITONS FROM ^{90}Zr. Flynn, E. R.; Blair, A. G.; Armstrong, D. D. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Phys. Rev., 170: 1142-56(June 20, 1968). (LA-DC-9112).

The inelastic scattering of tritons from ^{90}Zr was studied at a beam energy of 20 MeV, and angular distributions of states up to 5.22 MeV of excitation were obtained. The data are compared with distorted-wave calculations, employing both collective and shell-model form factors. Both calculations reproduce the shapes of the experimental angular distributions quite well. Values of deformation parameters obtained from the collective-model form-factor calculation are in good agreement with the results

of inelastic scattering experiments employing beams of ^{3}He and ^{4}He ions, but are in poor agreement with the results of proton inelastic scattering measurements. The shell-model analysis assumed an effective two-body interaction between the triton projectile and the target nucleons, and the form-factor calculation employed a Yukawa well with a 1.0-F range. Under these conditions, an effective interaction strength averaging 660 MeV was obtained for the excitation of the well-known pure proton-configuration states. This value is approximately three times the strength obtained in the previous study of proton inelastic scattering from these states. This result supports the assumption that the optical potential has a real well depth approximately three times as great for the triton as for the single nucleon. The strengths of the transitions to the other observed states are also discussed in terms of configurations expected to contribute to the states. Characteristics of the (t,t′) reaction are compared with those of the (p,p′) reaction. (auth)

37361 EXCITATION FUNCTIONS, RECOIL RANGES, AND STATISTICAL-THEORY ANALYSIS OF REACTIONS INDUCED IN ^{90}Zr WITH 25- TO 80-MeV HELIUM IONS. Yu, Yu-wen; Blann, Marshall (Univ. of Rochester, N. Y.). Phys. Rev., 170: 1131-41(June 20, 1968).

Excitation functions and mean recoil ranges were measured for radioactive products resulting from the helium-ion bombardment of natural zirconium and targets which were isotopically enriched in ^{90}Zr. Helium-ion energies varied between 25 and 80 MeV. Products observed were ^{93}Mo, ^{90}Nb, ^{89}Zr, ^{88}Zr, ^{88}Y, ^{87}Zr, ^{87}Y, ^{86}Zr, and ^{86}Y. The excitation function was also measured for the production of ^{87}Y. The recoil ranges are compared with the range theory of Lindhard, Scharff, and Schiott to determine the energy ranges over which the production of the nuclide is consistent with major contributions from a compound-nucleus mechanism. Excitation functions for products with A ≥ 87 were compared with the statistical model to investigate the influence of shell structure on level densities. The level-density models used were those due to Newton and to Rosenzweig in addition to the standard Fermi-gas level density. Rosenzweig's model gave the best overall agreement with the experimental results, with the standard Fermi-gas level density a close second. Several excitation functions were calculated using the s-wave approximation to estimate the effect of γ-ray de-excitation due to angular-momentum restrictions. Threshold position and excitation-function widths were found to agree quite satisfactorily with experimental values when this was done. (auth)

37362 COMMENTS ON THE ENERGETICS OF TERNARY (LIGHT-PARTICLE-ACCOMPANIED) FISSION. Feather, N. (Univ. of Edinburgh). Phys. Rev., 170: 1118-26(June 20, 1968).

A critical survey is given of the "differential energetics" of the binary and α-particle-accompanied ternary (thermal-neutron-induced) fission of ^{235}U. The Q-value for such a fission process (in a particular mode) is defined as the sum of the kinetic energies T and the deformation-excitation energies E of the resulting particles at a time some 10^{-18} sec later than the instant of scission. It is found that for ^{235}U(n$_{th}$,f) the difference of the mean kinetic energies is known more accurately than the difference of the mean deformation-excitation energies. However, on certain rather arbitrary assumptions, the difference of the mean Q-values is calculable, using the mass tables, with considerably more accuracy than that with which either of the experimentally determined quantities is known. On this basis, the following best values are obtained for the thermal-neutron-induced fission of ^{235}U: $\langle Q_b \rangle - \langle Q_{t\alpha} \rangle = 4.54 \pm 0.10$ MeV; $\langle T_b \rangle - \langle T_{t\alpha} \rangle = -2 \pm 2$ MeV; and $\langle E_b \rangle - \langle E_{t\alpha} \rangle = 6.5 \pm 2$ MeV. These values are discussed in relation to other evidence, and the importance of a detailed investigation of the secondary neutrons of α-particle-accompanied fission (with particular reference to the question of scission neutrons) is emphasized. The near equality of $\langle T_b \rangle$ and $\langle T_{t\alpha} \rangle$ implies no more than that the representative ("mean") event which is α-particle-accompanied ternary fission develops in time in such a way that at some stage it passes through the configuration which is the representative ("mean") configuration of binary scission. This conclusion in no way discriminates between the one-stage and two-stage descriptions of the ternary fission process. (auth)

37363 MASS SPECTROMETRIC DETERMINATION OF THE RELATIVE CROSS SECTION OF THE REACTION ^{133}Cs(p,2pxn)$^{132-x}$Xe. Levskii, L. K.; Murin, A. N.; Yutlandov, I. A. Radiokhimiya, 10: 265-8(1968). (In Russian).

Cs was irradiated with protons at 660 MeV, and the Xe isotopes formed were determined by mass spectrometry. The relative amounts of each isotope produced were determined; the results are tabulated. The reactions leading to the formation of the individual isotopes are discussed. The isotopic ratios obtained are compared with the results of the isotopic analysis of the xenon determined in meteorites. (J.S.R.)

37364 MEASUREMENTS OF ^{235}U AND ^{239}Pu NEUTRON CAPTURE-TO-FISSION RATIO FOR RESONANCE INCIDENT NEUTRON ENERGIES. Ryabov, Yu. V.; Don-Sslk, So; Chikov, N.; Yaneva, N. At. Energ. (USSR), 24: 351-62(Apr. 1968). (In Russian).

The neutron fission cross sections and capture-to-fission ratios of ^{239}Pu and ^{235}U were measured in the neutron energy ranges 5 eV to 23 keV and 0.15 eV to 30 keV, respectively, using the time-of-flight method. Fission events were registered by delayed coincidence between prompt γ-ray pulses and slowed fission neutrons. The counting rate of capture events was determined by the anticoincidences. The capture-to-fission ratios and the fission cross sections are presented as functions of energy. Values of the capture and fission resonance integrals are tabulated. (D.C.W.)

37365 THE γ SPECTRUM EMITTED DURING THE β DECAY OF ^{233}Th. Sebille, Claire; Leang, Chin Fan (CNRS, Orsay, France). Compt. Rend., Ser. A and B, 266: 1049-52(Apr. 8, 1968). (In French).

A study, with the aid of a germanium junction, of the γ spectrum emitted during the de-excitation ^{233}Th → ^{233}Pa showed the existence of 98 transitions of which 86 were observed for the first time. (tr-auth)

37366 L AND M INTERNAL CONVERSION OF THE E2 TRANSITIONS 130.5- AND 307.7-keV OF ^{169}Tm. Gizon, Jean; Baudry, Andre (CEN, Grenoble, France). Compt. Rend., Ser. A and B, 266: 1158-60(Apr. 22, 1968). (In French).

A high-resolution study was made of the internal conversion in the L and M subshells for the pure E2 transitions of 130.5 and 307.7 keV in ^{169}Tm. The results are compared with the theoretical values of Hager and Seltzer. (tr-auth)

37367 MULTIPOLARITY OF SOME TRANSITIONS IN THE DECAY ^{105}Ag → ^{105}Pd. Rivier, Janine; Gizon, Andree (Institut des Sciences Nucleaires, Grenoble, France). Compt. Rend., Ser. A and B, 266: 1161-4(Apr. 22, 1968). (In French).

A study of the γ spectrum from the decay ^{105}Ag → ^{105}Pd permits the multipolarity of several transitions to be determined. (tr-auth)

37368 NUCLEAR LEVELS OF ^{109}Ag. Bashandy, E.; El-Sayad, G. M. (Atomic Energy Establishment, Cairo). Atomkernenergie, 13: 188-92(May-June 1968).

The energy levels in ^{109}Ag populated by the decay of ^{109}Pd were analyzed in the light of internal conversion electrons studied by means of an iron-free, double-focusing beta-ray spectrometer. Conversion electrons were observed for 21 transitions, and their relative K-conversion electrons intensities were reported. The K-conversion coefficient of the 556-keV E2 transition was measured by the internal-external conversion method to be 0.0039 ± 0.0004, which agrees with theory (0.0041). This conversion coefficient was used to normalize relative K-electron and gamma-ray intensities to obtain conversion coefficients for most transitions in the decay of ^{109}Pd. The spins and parities of the following excited levels (energies in keV) in ^{109}Ag are observed: 88($\frac{1}{2}^+$), 218($\frac{5}{2}^+$), 259($\frac{1}{2}^+$), 306($\frac{3}{2}^-$), 411($\frac{3}{2}^-$), 441($\frac{1}{2}^-$), 641($\frac{3}{2}^-$), 708($\frac{3}{2}^-$), 723($\frac{5}{2}^-$), and 862($\frac{1}{2}^-$). The proposed level scheme is discussed in terms of nuclear models. (auth)

37369 PROMPT NEUTRONS FROM FISSION OF ^{238}U INDUCED BY 12-MeV PROTONS. Cheifetz, Eli; Fraenkel, Zeev (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev. Lett., 21: 36-9(July 1, 1968).

The number of prompt neutrons and their average energies in correlation with fragment mass and kinetic energy were measured directly for fission induced in ^{238}U by 12-MeV protons. The sawtooth behavior evident for the average number of neutrons as a function of fragment mass (similar to the behavior in thermal neutron fission of ^{233}U, ^{235}U, and ^{239}Pu) disappears for events of low total kinetic energy. (auth)

37370 PROTON-PARTICLE, NEUTRON-HOLE MULTIPLETS IN ^{209}Bi. Alford, W. P.; Schiffer, J. P.; Schwartz, J. J. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 21: 156-8(July 15, 1968).

The reactions ^{207}Pb(^{3}He,d)^{208}Bi and ^{209}Bi(d,t)^{208}Bi are found to excite the single-proton states coupled to the $3p_{\frac{1}{2}}$ neutron hole in ^{208}Pb and the single-neutron hole states coupled to the $h_{\frac{9}{2}}$ proton added to ^{208}Pb, respectively. Each particle-hole configuration forms a multiplet of states. Nine such multiplets have been identified, most of them for the first time. Tentative spin assignments based on intensities are proposed; a comparison with theoretical calculations gives remarkable agreement. (auth)

37371 AN INVESTIGATION OF ISOMERIC TRANSITIONS FOLLOWING THE DECAY OF ^{237}Np, ^{241}Am, AND ^{243}Am. Oberhofer, Edward Samuel. Raleigh, N. C., North Carolina State Univ., 1968. 82p.

Thesis.

Semiconductor detectors were employed in the study of the half-lives of certain transitions following the decay of ^{237}Np, ^{241}Am, and ^{243}Am and in the investigation of the gamma spectra from sources of these nuclides. Each of the levels whose half-life was measured is populated by an alpha-particle transition and depopulated by a gamma-ray transition. Silicon surface barrier detectors were used for alpha-particle detection and an NaI scintillator mounted on a photomultiplier was used for gamma-ray detection in the half-life measurements. A lithium-drifted germanium detector was used for gamma-ray detection in the gamma spectra measurements. An IBM 360 Model 30 computer was used to fit the half-life data to a simple exponential function by the method of least squares. The ^{237}Np source yielded two timing measurements. The half-life associated with the 86.9-keV gamma-ray transition was found to be $36.8 \pm 1.6 \times 10^{-9}$ sec, while the half-life associated with the higher energy transitions was assigned an upper limit of $1.02 \pm 0.07 \times 10^{-9}$ sec. The gamma transitions of energy, 145 keV, 196 keV, and 212 keV, were found to be the probable contributors to the faster transition. The half-life associated with the 59.6-keV gamma-ray transition from ^{241}Am was measured to be $64.2 \pm 2.0 \times 10^{-9}$ sec. The 74.6-keV transition from the ^{243}Am source was found to have associated with it a half-life of $1.41 \pm 0.04 \times 10^{-9}$ sec. (Disser. Abstr.)

37372 THE TOTAL NEUTRON CROSS SECTION OF 115-DAY ^{182}Ta FROM 0.01 TO 1000 eV. Stokes, G. E.; Schuman, R. P.; Simpson, O. D. (Idaho Nuclear Corp., Idaho Falls). Nucl. Sci. Eng., 33: 16-23(1968).

The total neutron cross section of ^{182}Ta was measured from 0.01 to 1000 eV using the MTR fast chopper. The observed total neutron cross section at 0.0253 eV is 8200 ± 600 b. Parameters of individual resonances below 30 eV and average parameters at higher energies give a resonance absorption integral of 943 ± 50 b and a neutron s-wave strength function $(\overline{\Gamma}_n^0/D)$ of $1 \pm 0.1 \times 10^{-4}$ $(eV)^{\frac{1}{2}}$. The possible use of ^{182}Ta as a neutron temperature monitor is discussed. (auth)

37373 ABSOLUTE RADIATIVE CAPTURE CROSS SECTION FOR FAST NEUTRONS IN ^{238}U. Menlove, H. O.; Poenitz, W. P. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng., 33: 24-30(1968).

The capture cross section of ^{238}U was measured absolutely at a neutron energy of 30 keV using kinematically collimated neutrons from the ^{7}Li(p,n)^{7}Be reaction near threshold. Activation techniques were used to determine both the number of capture events and the number of neutrons that occurred during the irradiation. The result of the ^{238}U capture cross section measurement is 479 ± 14 mb at 30 keV. In addition, the shape of the ^{238}U capture cross section was measured for neutron energies from 25 to 500 keV using neutrons from the ^{7}Li(p,n)^{7}Be reaction. The capture reactions in the ^{238}U target were detected using a large liquid scintillator tank and time-of-flight techniques. The relative neutron flux was measured using a flat response neutron detector. The cross-section shape measurement was normalized to the present absolute measurement at 30 keV. The present measurement was compared with several measured values, theoretical calculations, and compiled values of the ^{238}U capture cross section as given by other authors. (auth)

37374 PHOTONEUTRON PRODUCTION FROM FISSION FRAGMENTS OF ^{235}U IN HEAVY WATER. Forbes, Preston Williams. Blacksburg, Va., Virginia Polytechnic Inst., 1968. 62p.

Thesis.

There have been several measurements of delayed photoneutrons from fission fragments of ^{235}U in heavy water. These measurements have spanned a time interval from a few seconds to many hours after fission. It is the object of this work to design a technique capable of resolving half-lives and abundances of short-lived delayed photoneutron groups, i.e., times less than a few seconds. This objective is achieved by pulsing a beam of neutrons from a beam port of the VPI research reactor by means of a slow mechanical chopper. The neutron beam is then allowed to impinge on a uranium target which is housed in a sphere of heavy water. During the time interval between pulses neutron detectors count delayed neutrons and delayed photoneutrons resulting from the fission fragments generated during the neutron pulse. The counts are stored in a time base multichannel analyzer. This technique has two chief advantages. The counts from one burst are superimposed on those of previous bursts allowing rapid accumulation of data. In addition, the fact that the chopper speed can be varied easily allows the experimenter to enhance a portion of the neutron decay curve. The enhancement is achieved by selecting a burst time to saturate the groups in the portion of the decay curve of interest but not to saturate longer groups. The usefulness of this technique has been demonstrated by reproducing three previously known delayed neutron groups and establishing two new delayed photoneutron groups. The half lives of the two photoneutron groups which were determined here are 7.39×10^{-2} seconds and 4.02×10^{-3} seconds with relative abundances of 0.0292 and 0.170, respectively, where the relative abundance is the fraction of the delayed neutrons and delayed photoneutrons. (Disser. Abstr.)

Nuclear Theory

Refer also to abstracts 37287, 37288, 37294, 37295, 37304, 37305, 37325, 37329, and 37362.

37375 (AD-664798) NON-ADIABATICITY OF BETA VIBRATIONS IN THE DAVYDOV MODEL. Abecasis, S. M.; Bosch, H. E.; Plastino, A. (Istituto de Investigacion Aeronautica y Espacial, Buenos Aires (Argentina)). July 1967. 7p. (LR-18). CFSTI.

The feasibility of an adiabatic treatment of beta vibrations for even-even rare-earth nuclei is investigated with the restricted formula of Davydov. The parameters γ and μ as deduced from the fitting of experimental data with Davydov-Chaban predictions are used as a zeroth-order approximation. For all the nuclei considered, at a certain stage of the iterative process, the parameters got out of the range of validity of the restricted formula. Taking into account the values of those parameters for other regions of the periodic table, the conclusion can be drawn that an adiabatic treatment of beta vibrations within the frame of the Davydov model cannot be made. (auth) (USGRDR)

37376 (JINR-P4-3814) RASCHET POSLEDOVATEL'NOGO ISPUSKANIYA CHASTITS VYSOKOVOZBUZHDENNYM YADROM S BOL'SHIM UGLOVYM MOMENTOM. (Calculation of Successive Particle Emission by Highly Excited Nucleus with a Large Angular Momentum). Il'inov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 21p. (In Russian). Dep.

The behavior of a highly excited nucleus, produced in the interaction of a heavy ion with a target nucleus, was studied. The calculation was made by the Monte Carlo method. Several nuclear reactions were considered, and various interaction characteristics were compared with experiment. The effect of the model parameters on these characteristics was investigated. (auth)

37377 NUCLEAR TEMPERATURES IN (α,n) REACTIONS. Magda, M. T.; Trutia, Elena; Alevra, A.; Lukas, Ingrid R.; Plostinaru, D.; Molea, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 179-80(1968).

The reduced spectra of evaporation neutrons from (α,n) reactions were fitted by the Fermi-gas level density. By analysis of the reduced spectra in the framework of the constant temperature model, a set of temperature values as a function of the mass number of the residual nucleus was obtained. Evidence that the effect of the pairing correlation is important at excitation energies below 4 MeV was obtained. (D.C.W.)

37378 REACTION MATRIX ELEMENTS FOR THE 0f-1p SHELL NUCLEI. Kuo, T. T. S.; Brown, G. E. (Princeton Univ., N. J.). Nucl. Phys., A114: 241-79(1968). (PUC-937-295).

The shell-model reaction matrix elements for the 0f-1p shell are calculated and tabulated. The matrix elements consist of two parts; the bare reaction matrix elements and the renormalizations due to core polarizations, which are both calculated with the Hamada-Johnston nucleon-nucleon potential. The core polarizations are evaluated for two cases; first for a ^{40}Ca core and then for a ^{48}Ca core. As a preliminary test, these matrix elements are compared with available empirical effective interactions and used to calculate (i) the spectra of the valence particles of ^{42}Ca, ^{42}Sc, ^{50}Ca, ^{50}Sc, and ^{50}Ti, (ii) changes of single-particle (hole) levels such as the changes of single-neutron levels from ^{41}Ca to ^{49}Ca, and (iii) the $0f_{\frac{7}{2}}$-$0d_{\frac{3}{2}}$ particle-particle states of ^{38}Cl and the corresponding particle-hole states of ^{40}K. In general, the calculated results are in good agreement with the experimental values, and the core polarization effects are usually of great importance. (auth)

37379 QUASI-PARTICLE DESCRIPTION OF 2^+ AND 3^- STATES OF DOUBLY EVEN SPHERICAL NUCLEI. Lombard, R. J. (Univ. of California, San Diego, La Jolla). Nucl. Phys., A114: 449-62(1968). (IPNO/TH-114).

The description of the first 2^+ and 3^- levels of spherical nuclei $90 \leq A \leq 150$ and $186 \leq A \leq 206$ is performed in the framework of the BCS theory. The residual interaction is taken as the superposition of the pairing force and of the multipole force. The short-range proton-neutron correlations are neglected. In addition to the valence nucleons, the core particles are taken into account; it allows the computation of the transition probabilities without any effective charge. Theoretical predictions concerning the E_2^+ and E_3^- energies, the B(E2) and B(E3) reduced transition probabilities and

the gyromagnetic factors g_2^+ are in good agreement with experiment. (auth)

37380 T = 0 EFFECTIVE INTERACTION IN THE sd SHELL. Cohen, S. (Argonne National Lab., Ill.); Halbert, E. C.; Pandya, S. P. Nucl. Phys., A114: 353-64(1968).

A simple model interaction for T = 0 two-nucleon states in sd shell nuclei is described. All the two-body matrix elements are expressed in terms of seven radial matrix elements (which later effectively reduce to three) as in an earlier paper. The values of the parameters are obtained by making a least-squares fit to observed level energies in ^{18}F and ^{19}F and are then used to calculate the level schemes of ^{20}F and ^{20}Ne. The parameters and the spectra obtained are compared with those calculated from realistic nucleon–nucleon forces. Such simple interaction forms as are used may be particularly valuable in assessing the sensitivity of shell-model results to the use of specific interactions or to truncations of the basis space or the like. (auth)

37381 SIMPLE SHELL-MODEL EXPRESSIONS FOR COULOMB ENERGIES. Hecht, K. T. (Univ. of Michigan, Ann Arbor). Nucl. Phys., A114: 280-8(1968).

It is shown that the main n-T dependent terms of the Coulomb energy have the same general form in the Wigner supermultiplet scheme as in the low seniority limit of the j-j coupling scheme of the shell model. (auth)

37382 COULOMB DISPLACEMENT ENERGIES IN THE $1f_{\frac{7}{2}}$ SHELL. Jaenecke, Joachim (Univ. of Michigan, Ann Arbor). Nucl. Phys., A114: 433-48(1968).

The experimental Coulomb displacement energies in the $1f_{\frac{7}{2}}$ shell (except one) can be described by Hecht's Coulomb energy equation with a standard deviation of 8.5 keV if it is assumed that the Coulomb interaction radius if 2.6 ± 0.5% larger for the completely filled shell than it is for the unfilled shell. The standard error of the calculated energies is 1.8 keV. Electromagnetic spin-orbit effects are indicated. The two Coulomb interaction energies V_0 and $\bar{V}_{even}$ which were obtained from the least-squares analysis are in very good agreement with the theoretically predicted values. The energy of the 0^+, T = 1 ground state of ^{42}Sc is too low and deviates by about 45 keV from the expected value. (auth)

37383 A STUDY OF COLLECTIVE MOTION. I. RIGID, LIQUID, AND RELATED ROTATIONS. Cusson, R. Y. (Univ. of Heidelberg). Nucl. Phys., A114: 289-308(1968).

Models of nuclear collective rotations are defined by giving the form of the velocity field versus position. Only fields which are linear in the particle coordinates are considered. The canonical formalism is developed in the presence of the constraints represented by the field specification. The usual quantization rules are then applied to form the quantal collective Hamiltonian. The rigid-body problem is first treated. The liquid rotator Hamiltonian is obtained, starting from a vorticity free field, for the quadrupole mode only but at arbitrary deformation. The quantal problem corresponding to a field with arbitrary amounts of rigid and liquid components is shown to correspond to liquid motion with quantized vorticity as in nonlinear quantum superfluids and is treated using the components of the complete moment of momentum tensor which generate rotations and shear deformations. Connections with the algebra of SL(3,R) are pointed out. Fields where the ratio of liquid to rigid components are given, before quantizing, with the help of an ansatz connecting this ratio with the pairing strength, yield values of the moment of inertia which are intermediate between the rigid and liquid values. Qualitative agreement with the experimental situation in heavy nuclei is obtained for this last case. (auth)

37384 ONE-BOSON-EXCHANGE POTENTIAL AND NUCLEAR MATTER. Kiang, D.; Preston, M. A.; Yip, P. (McMaster Univ., Hamilton, Ont.). Phys. Rev., 170: 907-15(June 20, 1968).

The one-boson-exchange potential model is studied in some detail. The parameters of a velocity-dependent potential based on such a model are fitted to reproduce two-body scattering data. This potential is then used in nuclear-matter calculations. It is shown that the average binding energy of a nucleon in nuclear matter and the saturation density are in reasonable agreement with the experimental values. (auth)

37385 COMPARISON BETWEEN THE R-MATRIX AND EIGENCHANNEL METHODS. Mahaux, C.; Weidenmueller, Hans A. (Univ. of Wisconsin, Madison). Phys. Rev., 170: 847-56 (June 20, 1968).

The R-matrix and eigenchannel methods for the calculation of the S matrix are investigated from the point of view of their range of validity and accuracy. It is shown that no serious difficulty arises in the R-matrix method provided negative boundary-condition parameters are used. Because the space of functions within which the Hamiltonian is diagonalized depends upon the eigenphases, and because of the occurrence of positive boundary-condition parameters, serious difficulties arise in the eigenchannel approach. In particular, the calculated cross sections may exhibit spurious resonance peaks. (auth)

37386 INTERFERING COMPOUND-NUCLEUS RESONANCES. Ullah, Nazakat; Warke, Chindhu S. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 170: 857-8(June 20, 1968).

It is shown that the unitary form of the low-energy collision matrix based on R-matrix theory and Feshbach's unified theory of nuclear reactions can always be put into a well-known pole-resonance form for the elastic scattering, which contains only independent observable resonance parameters. The importance of the unitary resonance form of the collision matrix is discussed in connection with the statistical study of the fluctuations of the cross sections and the intermediate resonances. (auth)

37387 CONFIGURATION MIXING AND J DEPENDENCE IN l = 3 STRIPPING AND PICKUP REACTIONS. Siemssen, R. H.; Maher, J. V.; Sachs, M.; Whitten, C. A. Jr. (Yale Univ., New Haven). Phys. Rev., 170: 891-3(June 20, 1968).

To study effects of configuration mixing on the forward angle J dependence in l = 3 stripping and pickup reactions, angular distributions for the (d,p) reaction on ^{48}Ti, ^{50}Cr, ^{54}Fe, and ^{58}Ni were measured for those final states which contain most of the $f_{\frac{7}{2}}$ or $f_{\frac{5}{2}}$ single-particle strength. At an incident energy of 19 MeV, these (d,p) reactions (with an average Q value of 6 MeV) correspond to the inverse (p,d) reaction measured at an incident energy of 25 MeV. The present data therefore can be directly compared with the ^{56}Fe and ^{58}Ni(p,d) data of Glashausser and Rickey. Significantly less J dependence is found for transitions to final states for which configuration mixing effects are unimportant. This observation thus strongly supports the explanation of the forward angle J dependence in terms of configuration mixing. (auth)

37388 NUCLEAR SCATTERING IN THE RANDOM PHASE APPROXIMATION. Lemmer, R. H.; Veneroni, M. (Institut de Physique Nucleaire, Orsay, France). Phys. Rev., 170: 883-90 (June 20, 1968).

A simple extension of the random phase approximation (RPA) is described that includes scattering channels of a single nucleon. Coupled equations are derived for the single-nucleon amplitudes that describe the scattering states of the nucleon by an assembly of identical nucleons. These equations reveal that the exclusion principle is taken into account by antisymmetrized interaction matrix elements plus the appearance of the projection operator $1 - \rho_0$ (ρ_0 is the single-particle density) into unoccupied single-particle states in the compound nucleus. The use of the RPA also introduces the effects of long-range correlations, the well-known "backward-going graphs" of many-body perturbation theory, in the scattering problem. The system of equations thus obtained contains no parameters beyond those describing the two-body matrix elements that generate the Hartree-Fock field that serves as a zero-order approximation to the excitations considered within the RPA. The scattering solutions of these equations are illustrated with a soluble model. It is shown that the presence of correlations in the wave functions of resonance states can influence their particle decay widths considerably. The important practical problem of angular-momentum decomposition of the coupled-equation system is also discussed. (auth)

37389 THEORETICAL FISSION-ANTINEUTRINO SPECTRUM AND CROSS SECTION OF THE REACTION ^{3}He($\bar{\nu}_e$,e$^+$)^{3}H. Avignone III, F. T.; Blakenship, S. M.; Darden III, C. W. (Univ. of South Caroline, Columbia). Phys. Rev., 170: 931-4(June 20, 1968).

The energy spectrum of antineutrinos emitted by binary fission fragments of ^{235}U in secular equilibrium was calculated. The primary fission yields used in this work were calculated, using the primary fission product charge distributions due to A. C. Wahl. The total number of antineutrinos per fission predicted with the calculated spectrum is 6.06. The antineutrino spectrum derived in this work was used to calculate the average cross section for the reaction p($\bar{\nu}_e$,e$^+$)n and ^{3}He($\bar{\nu}_e$e$^+$)^{3}H. The cross sections are 1.09×10^{-43} cm^2/(fission $\bar{\nu}$) and 2.46×10^{-43} cm^2/(fission $\bar{\nu}$), respectively. (auth)

37390 Q-VALUES IN α-PARTICLE-ACCOMPANIED TERNARY FISSION. Feather, N. (Univ. of Edinburgh). Phys. Rev., 170: 1127-31(June 20, 1968).

In relation to any mode of binary fission, there are nine possible ways in which the constituents of an α particle can be assembled using nucleons from one or both of the nascent binary fragments. Basing a definition of "corresponding modes" on this fact, the one-stage view of the process of α-particle-accompanied ternary fission is examined from the standpoint that the relative probabilities of occurrence of the nine related modes should be directly correlated with the respective Q-values. Q-value differences in

respect of a representative selection of binary and corresponding α-particle-accompanied ternary modes of thermal-neutron induced fission of ^{235}U are evaluated and discussed from this point of view. The results reflect the fact that the fissioning nucleus ^{236}U is an even-even nucleus (as, indeed, are all nuclei whose low-energy fission properties have been closely studied). Ternary modes in which the α particle accompanies two residual fragments, each of which is an even-even species, appear generally to be the most highly favored, and, except when the related binary mode is an odd-odd mode (when the even-even ternary mode results from the contribution of one neutron and one proton from each of the nascent binary fragments), there is a marked tendency for the most favored even-even ternary mode to be that in which the whole α particle is contributed by the heavier fragment. These highly favored even-even ternary modes do not always correspond to most probable binary modes (values of the mass ratio being specified); frequently they correspond to binary modes in which the neutron excess of the heavy fragment is two or even four units less than for the most probable mode. Formally, ternary modes which involve the release of the whole α particle from one nascent fragment, with no contribution from the other, can equally well be described on the basis of a one- or two-stage view of the over-all process. (auth)

37391 ISOSPIN INVARIANCE AND THE PAIRING-FORCE PROBLEM. Ginocchio, J. N.; Weneser, J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 170: 859-79(June 20, 1968). (BNL-11897).

The isoscalar pairing-force Hamiltonian is studied first in the BCS-like approximation, including neutron-neutron, proton-proton, and neutron-proton interactions. Constraining $\langle\hat{N}\rangle$ and $\langle\hat{T}^2\rangle$, a class of BCS-like wave functions is found which gives the same minimum energy; they differ in the expectation value of $\hat{T}_z$, $-T \leq \langle\hat{T}_z\rangle \leq T$. For the limit $\langle\hat{T}_z\rangle = T$, the minimum occurs at zero neutron-proton interaction. The residual interactions, those neglected by the BCS approximation, are treated by the quasiboson approximation. The spurious effects of number and isospin dispersion are identified. A procedure for explicitly displaying the number and isospin dependence of the energy is given, together with one for obtaining excited states with all possible isospins. Finally, as an example, the degenerate case is worked out; and agreement with exact solution, including ground-state neutron-proton correlations, to the order considered, is demonstrated. (auth)

37392 HARTREE-FOCK-BOGOLIUBOV PROJECTED SPECTRA FOR FINITE NUCLEI. Warke, Chindhu S.; Khadkikar, S. B. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 170: 1041-6(June 20, 1968).

Explicit expressions convenient for numerical calculations are derived for the number- and total-spin-projected spectrum of a nucleus from its Hartree-Fock-Bogoliubov solution. Suitable approximation to such a spectrum is found. The applications of these results are also carried out. (auth)

37393 DAMPING OF ISOBARIC ANALOGUE STATES. De Toledo Piza, A. F. R. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science, Cambridge, Mass.); Kerman, A. K.; Fallieros, S.; Venter, R. H. Contracts AT(30-1)-2098; AT(30-1)-3525. Nucl. Phys., 89: 369-76(1966). (NYO-3525-9).

The spreading width of analogue states due to the Coulomb interactions in a nucleus is calculated. The coupling to single-particle, two-particle, one-hole and three-particle, two-hole configurations is considered. The effect of nuclear interactions is taken account in the large energy separation between the analogue and the configuration states (symmetry energy displacement) and in the natural distribution of the latter representing their fragmentation. The spreading widths are found to be small, less than 3 keV in ^{89}Y and ^{91}Nb. (auth)

37394 KINEMATIC BROADENING IN TWO-BODY COLLISIONS AT RELATIVISTIC ENERGIES. Smith, D. L. (Redstone Arsenal, Ala.). Nucl. Instrum. Methods, 63: 23-8(July 15, 1968).

Kinematic broadening is studied for two-body collisions in which the kinetic energies of the interacting particles are large enough to require relativistic analysis. Three overlapping categories of problems are treated. For each category, a formula is derived which can be used in the calculation of kinematic broadening. The first category includes collisions in which the kinetic energies of the particles may be of the same order of magnitude as their rest-mass energies. The formula which is derived for this category is very general and may be used regardless of the energies of the interacting particles. The second category consists of ultrarelativistic collisions. Here it is assumed that the kinetic energies of the incident and emitted particles are considerably larger than their rest-mass energies. Finally, the third category includes collisions which are only slightly relativistic in the sense that the kinetic energies of the interacting particles are considerably smaller than their rest-mass energies. Each of the formulas derived is an expansion in the small angular deviations from the mean direction of emission of the observed particles. These formulas may be applied to problems in atomic, nuclear, and high-energy physics. Their use is demonstrated by means of three numerical examples. (auth)

37395 ON THE GREEN'S FUNCTIONS APPROACH IN THE THEORY OF NUCLEAR MATTER. Rohozinski, S. G. (Warsaw Univ.). Acta Phys. Pol., 33: 505-19(Apr. 1968).

The method of Green's functions is applied to investigate the ground-state properties of nuclear matter treated as a large bound system of fermions interacting through short-range forces. An approximation which consists in neglecting three-body correlations is considered. Since all quantities of interest can be expressed by spectral functions of Green's functions, the latter have to be found. So, equations for the spectral functions of the self-energy and the vertex part are derived. Additional approximations are made in the case of normal systems. Damping effects are neglected or an independent-particle model is introduced to get a correspondence with the generalized ladder approximation in the perturbation theory. The Brueckner-type scheme is obtained at the low-density limit. In this scheme there appear only single-particle energies and their derivatives on the energy shell. (auth)

37396 PHASE FUNCTION METHOD IN QUANTUM MECHANICS. Babikov, V. V. Usp. Fiz. Nauk, 92: 1-26(May 1967). (In Russian).

A brief review is given of the basic equations and the applications of the new methods of phase functions. The treatment of potential scattering is considered in detail. (R.V.J.)

37397 QUASIPARTICLES IN THE NUCLEAR THEORY. Migdal, A. B. Usp. Fiz. Nauk, 92: 27-64(May 1967). (In Russian).

The formulation of various problems in nuclear theory in terms of quasiparticle interaction constants is discussed. The appropriate Feynman diagrams, nuclear moments, beta transitions, nuclear reactions, and electromagnetic transitions are considered in some detail. (R.V.J.)

37398 TWO-QUASIPARTICLE 1^+ STATES IN EVEN-A, SINGLE-CLOSED-SHELL NUCLEI. Lombard, R. J. (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 21: 102-4 (July 8, 1968).

The quasiparticle model is applied to the study of low-energy 1^+ levels in single-closed-shell nuclei. Some of their properties are discussed. (auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 35879 and 36016.

37399 (AE–321) STABILITY OF A STEAM COOLED FAST POWER REACTOR, ITS TRANSIENTS DUE TO MODERATE PERTURBATIONS AND ACCIDENTS. Vollmer, Heinz (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1968. 36p. Dep.

The dynamic behavior of a steam cooled fast power reactor is described with respect to stability, transients due to moderate perturbations at the operating point, and accidents. The studies are performed for a direct cycle, integral plant design for different system pressures, component arrangements and component designs. The stability domain of such a plant is found to be mainly determined by pressure, fuel temperature and coolant density coefficients of reactivity. Other design parameters are of minor influence on stability. The plant is load-following and displays acceptable performance if the reactivity coefficients are not too close to their limiting values. If they are, effective controllers can be designed which ensure good plant operation. The consequences of accidents may be limited by proper design and adequate counteraction. (auth) (Sweden)

37400 (AECL–3109) MASS BALANCE ESTIMATE OF THE ENERGY RELEASED PER FISSION IN A REACTOR. Walker, W. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1968. 10p. Dep. CFSTI. CAN $0.50.

To obtain the energy per fission appearing as heat in a reactor, estimates are required for the energy carried away by neutrinos, the β-decay energy of long-lived fission products and the binding energy of (ν-1) neutrons captured in fuel, fission products, control rods or equivalent, moderator, structural materials, and shielding. Loss of energy by γ-rays and neutrons leaking through the shielding is assumed to be negligible. The calculations have been done for thermal neutron fission of ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu and fast fission of ^{232}Th and ^{238}U. The calculated "MeV per fission" appearing in a CANDU-type reactor are: ^{232}Th, 196.2 ± 1.1; ^{233}U, 199.0 ± 1.1; ^{235}U, 201.7 ± 0.6; ^{238}U, 208.5 ± 1.1; ^{239}Pu, 210.7 ± 1.2; ^{241}Pu, 213.8 ± 1.0. (auth)

37401 (ANL–7457) REACTOR DEVELOPMENT PROGRAM. Progress Report, May 1968. (Argonne National Lab., Ill.). July 2, 1968. Contract W-31-109-eng-38. 148p. Dep. CFSTI.

This monthly progress report includes information on EBWR, LMFBR, ZPR-3, ZPR-6, ZPR-9, ZPPR, EBR-II, general reactor technology, and reactor safety including TREAT operations. For detailed information, see the annual reports from the following ANL Divisions: Chemical Engineering, Metallurgy, Reactor Engineering, and Reactor Physics. 25 references. (D.C.C.)

37402 (ANL–7450, pp 75–89) REACTOR SAFETY. (Argonne National Lab., Ill.).

Topics discussed include: thermal reactor safety studies of loss-of-coolant accidents and pressure generation due to particle coolant energy transfer; and fast reactor safety studies of high temperature physical properties, pressure generation due to particle coolant energy transfer, reaction of violently sprayed sodium with air, and migration of fuel components under a thermal gradient. (D.C.C.)

37403 (ANL-Trans–625) SODIUM BOILING IN THE CORE OF FAST REACTORS. Semeria, R. Translated by Betty Guttman (Argonne National Lab., Ill.), from Bull. Inform. Sci. Tech. (Paris), No. 122, 19-23(Jan. 1968). 7p. Dep. CFSTI.

The conditions under which boiling can occur in the core of a Na-cooled fast reactor are examined, and the physics of Na boiling initiation, the development of the boiling zone, and the dry-out effects on the fuel element cladding are discussed. (H.D.R.)

37404 (APDA–303) EVOLUTION AND DESIGN OF THE MACHINERY DOME FOR THE ENRICO FERMI ATOMIC POWER PLANT. Wagner, N. H. (Atomic Power Development Associates, Inc., Detroit, Mich.). June 10, 1968. Contract AT(11-1)-865. 199p. Dep. CFSTI.

The machinery dome is a vessel which forms the upper closure of the primary shield tank, when bolted to the mating flange of the primary shield tank above the machinery deck. The primary shield tank and the machinery dome completely surround the reactor vessel. Gas leakage through the rotating shield plug in the neck of the reactor vessel may be contained within the machinery dome. The design of the machinery dome for the Enrico Fermi fast breeder reactor is described. Noteworthy problems which have been encountered are discussed in depth. The testing which was required to qualify certain details of the design is described when applicable. (auth)

37405 (APDA-CFE–20) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, MARCH 1968. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). June 1968. Contract AT(11-1)-865. 47p. Dep. CFSTI.

Topics discussed include: object removal from inlet plenum; investigation of Zr segments; removal of spherical mirror from the reactor; operations; equipment; nonfissionable materials surveillance program; and maintenance. (D.C.C.)

37406 (BNWL–518(Del.)) SURVEY OF HYDRAULIC MODELING EXPERIENCE FOR REACTOR CORE SYSTEMS. Hayden, K. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1967. Contract AT(45-1)-1830. 51p. Dep. CFSTI.

The fluid-flow system of the Fast Flux Test Facility reactor core is analyzed. Model studies of the reactor vessel and core system are discussed. Lists of nine selected reactor sites, reactor types, model size and experimental studies conducted for design support are presented. (D.C.C.)

37407 (BNWL–801) REACTOR PHYSICS DATA FOR THE UTILIZATION OF PLUTONIUM IN THERMAL POWER REACTORS. Schmid, L. C.; Leonard, B. R. Jr.; Liikala, R. C.; Smith, R. I. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 143p. Dep. CFSTI.

Experimental reactor physics data have been and are currently being obtained in the United States to study the utilization of plutonium in present-day thermal reactors. A reference for what data exist and where it can be found is presented. References to data for lattices moderated with H_2O, D_2O, and graphite are included. However, discussions are centered around the use of plutonium in H_2O reactors because these reactor types are of most interest in the United States. Problems connected with calculating H_2O-plutonium systems are illustrated using the data, and areas are mentioned in which needs for additional data still exist. Cross sections, criticality, reactivity coefficients, kinetics, and burnup data are referred to and conclusions are made about the use of the data in evaluating methods and cross sections for H_2O moderated reactors. 391 references. (auth)

37408 (CVNA–282) D_2O LOSS ANALYSIS FOR THE CAROLINAS–VIRGINIA TUBE REACTOR. Smith, J. Ed. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). June 1967. 36p. Dep. CFSTI.

The total D_2O loss from the start of the initial fill on March 23, 1963, until May 29, 1967, is discussed. Topics discussed include: experience with design features for protection and recovery of D_2O; known sources of leakage and losses; inventory methods used; and results of combined efforts to prevent D_2O loss. (auth)

37409 (DOCKET-50255–1) PALISADES PLANT. Preliminary Description and Safety Analysis Report, Vol. 1. (Consumers Power Co., Jackson, Mich.). June 3, 1966. 148p. Dep. CFSTI.

Information on the Palisades Power Reactor is given under the following broad topics: Introduction and Summary; Site and Environment; Reactor; Primary Coolant System; and Containment System. (M.L.S.)

37410 (DOCKET-50255–2) PALISADES PLANT. Preliminary Description and Safety Analysis Report, Vol. 2. (Consumers Power Co., Jackson, Mich.). June 3, 1966. 152p. Dep. CFSTI.

Information on Palisades Power Reactor is given under the following broad subjects: Engineered Safeguards including the safety injection system, containment spray system, and containment air recirculation and cooling system; Instrumentation and Control; Electrical Systems; Auxiliary Systems including chemical and volume control system, auxiliary heat removal system, facility service systems, sampling system, and refueling system; Steam and Power Conversion System; Radioactive Waste and Radiation Protection; Conduct of Operations; Initial Tests and Operation; Safety Analyses including core and coolant boundary protection, loss-of-coolant accidents, and fuel handling accidents; and Conformance with USAEC Proposed General Criteria for Nuclear Power Plant Construction Permits. (M.L.S.)

37411 (DOCKET-50255–3) PALISADES PLANT. Preliminary Description and Safety Analysis Report, Vol. 3. (Consumers Power Co., Jackson, Mich.). June 3, 1966. 153p. Dep. CFSTI.

Information on the Palisades Power Reactor is contained in

Appendices to the original PSAR; these include: structural design bases, design program for the containment structure, meteorology, foundation investigation, and seismic survey. (M.L.S.)

37412 (DOCKET-50255-4) PALISADES PLANT. [Preliminary Description and Safety Analysis Report], Amendment 1. (Consumers Power Co., Jackson, Mich.). Sept. 6, 1966. 331p. Dep. CFSTI.

Additional information on the Palisades Power Reactor is given. Material is included on the following broad subjects: overall quality control and design, construction materials and practices, containment, liner design, structural design, containment spray system, containment air recirculation and cooling system, electrical power supply, and primary coolant system. (M.L.S.)

37413 (DOCKET-50255-5) [PALISADES PLANT]. [Preliminary Description and Safety Analysis Report], Amendment 3. (Consumers Power Co., Jackson, Mich.). Nov. 1, 1966. 147p. Dep. CFSTI.

Additional and revised information on the Palisades Power Reactor is given on the engineered safety systems. Redundancy of the instrumentation for the engineered safeguards is evaluated; complete flow diagrams of the safety injection and shutdown cooling systems are included; logic diagrams are shown. Loss-of-coolant accidents are analysed as a function of piping break size; detailed data are shown graphically. Calculations of dose rates during a design basis accident are tabulated. (M.L.S.)

37414 (DOCKET-50255-6) [PALISADES PLANT]. [Preliminary Description and Safety Analysis Report], Amendment 4. (Consumers Power Co., Jackson, Mich.). Nov. 30, 1966. 123p. Dep. CFSTI.

Additional or revised information on Palisades Power Reactor is given under the following broad topics: instrumentation and control, containment systems, control rod drive mechanisms, response of core support structures to hydraulic loads associated with blowdown, and results of compression tests of 90-wire anchor head assembly. (M.L.S.)

37415 (DOCKET-50255-8) [PALISADES PLANT]. [Preliminary Description and Safety Analysis Report], Amendment 6. (Consumers Power Co., Jackson, Mich.). Jan. 3, 1967. 61p. Dep. CFSTI.

Additional or revised information on Palisades Power Reactor is given on the safety injection system, control rod ejection accidents, and control rod testing and performance. Revised flow diagrams are included for: service and recirculating water system and main steam and condensate systems; additional containment design information is given. (M.L.S.)

37416 (DOCKET-50255-9) [PALISADES PLANT]. [Preliminary Description and Safety Analysis Report], Amendment 7. (Consumers Power Co., Jackson, Mich.). Jan. 11, 1967. 13p. Dep. CFSTI.

Revised information on the cooling system for the Palisades Power Reactor is given. Coolant flow distribution for less than four pumps running is tabulated. (M.L.S.)

37417 (DOCKET-50261-1) H. B. ROBINSON UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Vol. 1. (Carolina Power and Light Co., Raleigh, N. C.). July 12, 1966. 180p. Dep. CFSTI.

Information on the H. B. Robinson Power Reactor, Unit 2, is given under the broad headings of Summary and Site and Environment. (M.L.S.)

37418 (DOCKET-50261-2) H. B. ROBINSON UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Vol. 2. (Carolina Power and Light Co., Raleigh, N. C.). July 12, 1966. 218p. Dep. CFSTI.

Information on H. B. Robinson Power Reactor, Unit 2, is given under the following broad topics: Reactor; Reactor Coolant System; Containment System; and Engineered Safeguards including the safety injection system, and containment spray system. (M.L.S.)

37419 (DOCKET-50261-3) H. B. ROBINSON UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Vol. 3. (Carolina Power and Light Co., Raleigh, N. C.). July 12, 1966. 260p. Dep. CFSTI.

Information on H. B. Robinson Power Reactor, Unit 2 is given under the following broad topics: Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion Systems; Radioactive Wastes and Radiation Protection; Safety Evaluation; and Organization and Training. Appendices include seismic design criteria, experience with high power level fuel rods, and method of analysis and assumptions for core slump. (M.L.S.)

37420 (DOCKET-50261-4) H. B. ROBINSON UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Amendment 2, Suppl. 1. (Carolina Power and Light Co., Raleigh, N. C.). Nov. 28, 1966. 185p. Dep. CFSTI.

Additional information on H. B. Robinson Power Reactor, Unit 2, is given on the following topics: site, plant control, net load rejection, plant layout, instrumentation and control systems, missile protection inside containment, pressure vessel and internals, ventilation systems, and safety injection system and accumulator. (M.L.S.)

37421 (DOCKET-50261-5) H. B. ROBINSON UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Amendment 3, Suppl. 2. (Carolina Power and Light Co., Raleigh, N. C.). Dec. 1, 1966. 161p. Dep. CFSTI.

Detailed information is given on the containment structure for the H. B. Robinson Power Reactor, Unit 2. Design parameters are given; load factor selection and loading calculations are described. Comparisons of calculated stresses for circumferential shell reinforcing steel, axial shell tendon, dome reinforcing steel, and base reinforcing steels are tabulated for test, accident and accident-earthquake conditions. Piling design is detailed; head movement is shown as a function of load. Details of tendon coupling are given. The prestressing system is evaluated. Containment structure construction and the associated quality control program is described. The in-service surveillance program is discussed. (M.L.S.)

37422 (DOCKET-50261-6) H. B. ROBINSON UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Amendment 4, Suppl. 3. (Carolina Power and Light Co., Raleigh, N. C.). Dec. 1, 1966. 307p. Dep. CFSTI.

Automatic control of power load demands for the H. B. Robinson Power Reactor, Unit 2, is discussed. Effects of tornadoes and hurricanes on Class I are analyzed. Containment structure inspection and quality control are detailed. Effects of transients on the pressure vessels, at the end of its fatigue life, are evaluated. A revised isolation valve seal water system is described. A complete list of piping penetrations is given; function and operation is indicated. Steady state and transient DNB ratios and fuel temperatures are evaluated. Actuation and functioning of the safety injection system and service water system are discussed. Heat and mass transfer coefficients are determined. Results of detailed blowdown calculations are given; data are shown graphically. Efficiency of engineered safeguards during loss-of-coolant accidents and blowdown is evaluated. Effects of a rod ejection accident are considered; enthalpy distribution in the core fuel is discussed; sensitivity to scram delay time is evaluated. Steam generator tube rupture is analyzed. Coolant fission product inventory is tabulated; effects of an atmospheric steam dump are evaluated. In-core plutonium isotopic content at end-of-life is determined; a hypothetical meltdown of plutonium-containing fuel is evaluated. (M.L.S.)

37423 (DOCKET-50261-7) H. B. ROBINSON UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Amendment 5, Suppl. 4. (Carolina Power and Light Co., Raleigh, N. C.). Dec. 1, 1966. 189p. Dep. CFSTI.

Effects of missile production from hypothetical turbine generator failure in the H. B. Robinson Power Reactor, Unit 2, are analyzed. Blowdown effects on reactor internals are evaluated; the steam generator feedwater system is described. A revised list of all containment penetrations and valves is given; piping penetration diagrams are included. A revised service water diagram is shown. Containment structure stress levels at load condition are tabulated; effects of radial and lateral shear are described. A finite element analysis technique for determining effects of large openings in containment vessels is discussed; also given is an elastic stability analysis of the containment vessel liner under applied compressive loads. A detailed dimensional analysis of the prestressing system is presented. The in-service tendon surveillance program is detailed. (M.L.S.)

37424 (DOCKET-50261-8) H. B. ROBINSON UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Amendment 6, Suppl. 5. (Carolina Power and Light Co., Raleigh, N. C.). Jan. 27, 1967. 79p. Dep. CFSTI.

A seismological analysis of the site for the H. B. Robinson Power Reactor, Unit 2, is presented. Additional field investigations for site environmental studies are described. A geologic analysis of the site is given. (M.L.S.)

37425 (DOCKET-50261-9) H. B. ROBINSON UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Amendment 7, Suppl. 6. (Carolina Power and Light Co., Raleigh, N. C.). Feb. 6, 1967. 64p. Dep. CFSTI.

Additional information for the containment system for the H. B. Robinson Power Reactor, Unit 2, is given. Stability of the earth

dam at the Robinson site is evaluated; plot diagrams are shown. An analysis of the effects of longitudinal shear on the containment vessel is given; a detailed description of pile design is included. The model for dynamic analysis of the containment vessel is described. (M.L.S.)

37426 (DOCKET-50267-10) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. [Preliminary Safety Analysis Report], Amendment 9. (Public Service Co. of Colorado, Denver). Jan. 4, 1968. 297p. Dep. CFSTI.

Revised information on the Fort St. Vrain Power Reactor, Unit 1 is included. The effects of the addition of silicon carbide to fuel particle coatings is analysed; particular attention is paid to activity releases. Additional information required by the ACRS on the prestressed concrete reactor vessel (PCRV) is given. This includes: PCRV liner failure analysis during loss of all forced circulation cooling, quantitative analysis of PCRV tendon failure, and description of PCRV test and inspection program. Detailed information related to operation at 879 MW(t) is given. (M.L.S.)

37427 (DOCKET-50286-1) INDIAN POINT NUCLEAR GENERATING, UNIT NO. 3. Description of Site and Environment. Preliminary Safety Analysis Report, Exhibit B, Vol. 1. (Consolidated Edison Co. of New York, Inc., New York). Apr. 26, 1967. 150p. Dep. CFSTI.

Detailed information on the site for the Indian Point Power Reactor, Unit 3 is given. This includes location, topography, population and land usage, hydrology, meteorology, geology, seismology, and environmental radioactivity. (M.L.S.)

37428 (DOCKET-50286-2) [INDIAN POINT NUCLEAR GENERATING, UNIT NO. 3]. [Preliminary Safety Analysis Report], Vol. 2. (Consolidated Edison Co. of New York, Inc., New York). Apr. 26, 1967. 175p. Dep. CFSTI.

Information on Indian Point Power Reactor, Unit 3, is given under the following major topics: Summary Description; Reactor; Reactor Coolant System; Containment System; and Engineered Safeguards including safety injection system, containment spray, containment ventilation system, containment isolation system, isolation valve seal water system, and containment penetration and weld channel pressurization system. (M.L.S.)

37429 (DOCKET-50286-3) [INDIAN POINT NUCLEAR GENERATING, UNIT NO. 3]. [Preliminary Safety Analysis Report], Vol. 3. (Consolidated Edison Co. of New York, Inc., New York). Apr. 26, 1967. 190p. Dep. CFSTI.

Information on Indian Point Power Reactor, Unit 3, is given under the following major topics: Plant Instrumentation and Control; Electrical System; Auxiliary and Emergency Systems; Steam and Power Conversion System; Radioactive Wastes and Radiation Protection; and Safety Evaluations including core and coolant boundary protection analysis, standby safeguards analysis, and major rupture of a reactor coolant pipe. Seismic design criteria are appended. (M.L.S.)

37430 (DOCKET-50293-1) PILGRIM NUCLEAR POWER STATION, PLYMOUTH, MASSACHUSETTS. Safety Evaluation. (Boston Edison Co., Mass.). May 20, 1968. 86p. Dep. CFSTI.

The safety evaluation for the Pilgrim Power Reactor, performed by the USAEC Division of Reactor Licensing, is given. Safety considerations for site, station design, accident analysis, requirements for further technical information, station design with respect to the 70 General Design Criteria, ACRS report, technical qualifications, and common defense and security are discussed. (M.L.S.)

37431 (DOCKET-50315-3) DONALD C. COOK NUCLEAR PLANT. Preliminary Safety Analysis Report, Vol. 1. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). Dec. 18, 1967. 525p. (DOCKET-50316-3). Dep. CFSTI.

Information on Donald C. Cook Power Reactor, Units 1 and 2, is given under the following broad topics: Summary Description; Site and Environment; Reactor; Reactor Coolant System; and Containment System. (M.L.S.)

37432 (DOCKET-50315-4) DONALD C. COOK NUCLEAR PLANT. Preliminary Safety Analysis Report, Vol. 2. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). Dec. 18, 1967. 437p. (DOCKET-50316-4). Dep. CFSTI.

Information on Donald C. Cook Power Reactor, Units 1 and 2, is given under the following broad headings: Engineered Safety Features including Emergency Core Cooling Systems and containment spray system; Plant Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion System; and Radioactive Waste and Radiation Protection. (M.L.S.)

37433 (DOCKET-50315-5) DONALD C. COOK NUCLEAR PLANT. Preliminary Safety Analysis Report, Vol. 3. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). Dec. 18, 1967. 301p. (DOCKET-50316-5). Dep. CFSTI.

Information on the Donald C. Cook Power Reactor, Units 1 and 2, is given under the following broad topics: Conduct of Operations; Initial Tests and Operation; and Safety Evaluation including core and coolant boundary protection, standby safeguards analysis, and loss-of-coolant accident analysis. Appendices include detailed site environmental studies, structure and equipment design criteria, functional evaluation of components which are shared by the two units, and determination of nil ductility transition temperature. (M.L.S.)

37434 (DOCKET-50315-6) DONALD C. COOK NUCLEAR PLANT. APPLICATION FOR CONSTRUCTION PERMIT AND OPERATING LICENSE. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). [1967]. 85p. (DOCKET-50316-6). Dep. CFSTI.

Financial data on the owners of the Donald C. Cook Power Reactor, Units 1 and 2, are given in support of the application for construction permit and operating license. The 1966 Annual Reports for the Indiana and Michigan Electric Company and the American Electrical Power are included. A schedule of estimated expenditures for the plant is given. (M.L.S.)

37435 (DOCKET-50323-1) NUCLEAR UNIT 2, DIABLO CANYON SITE. Preliminary Safety Analysis Report, Vol. 1. (Pacific Gas and Electric Co., San Francisco, Calif.). July 1, 1968. 450p. Dep. CFSTI.

Information on Diablo Canyon Power Reactor, Unit 2, is given under the following broad topics: Summary Description; Site and Environment; Reactor; Reactor Coolant System; and Containment System. (M.L.S.)

37436 (DOCKET-50323-2) NUCLEAR UNIT 2, DIABLO CANYON SITE. Preliminary Safety Analysis Report, Vol. 2. (Pacific Gas and Electric Co., San Francisco, Calif.). July 1, 1968. 342p. Dep. CFSTI.

Information on Diablo Canyon Power Reactor, Unit 2, is given under the following broad topics: Engineered Safety Features including Emergency Core Cooling Systems, containment spray, containment isolation, containment ventilation, and leak detection; Instrumentation and Control; Electrical Systems, Auxiliary and Emergency Systems; and Steam and Power Conversion System. (M.L.S.)

37437 (DOCKET-50323-3) NUCLEAR UNIT 2, DIABLO CANYON SITE. Preliminary Safety Analysis Report, Vol. 3. (Pacific Gas and Electric Co., San Francisco, Calif.). July 1, 1968. 473p. Dep. CFSTI.

Information on Diablo Canyon Power Reactor, Unit 2, is given under: Radioactive Wastes and Radiation Protection; Safety Evaluation and Operation. Appendices contain detailed information and data on meteorology, geology, seismology, seismic design, Tsunami studies and potential, stress criteria for vessels and piping, and quality assurance. (M.L.S.)

37438 (DUN-SA-65) ELECTRONIC SYSTEMS FOR NUCLEAR REACTOR PROTECTION. Swezea, G. L. (Douglas United Nuclear, Inc., Richland, Wash.). Apr. 3, 1968. 9p. (CONF-680803-1). Dep. CFSTI.

From Western Electronic Show and Convention Conference, Los Angeles, Calif.

The increased number of nuclear power generation plants planned or being designed make it important that the performance and reliability of Nuclear Reactor Protection systems be continually reviewed and improved. The proposed IEEE Standards for Nuclear Power Plant Protection System could well be the basis for new designs and improvements of existing systems. The conventional power plant protection systems involve start-up and power range flux monitoring equipment. The use of improved automatic instruments for total flux range monitoring is discussed. Recent investigations of wide range stack monitoring are also discussed. The introduction of solid state instrumentation for reactor monitoring has opened the door for use of dc powered instruments. A pressure monitoring system of this type is discussed. (auth)

37439 (EURFNR-462) FAST SODIUM-COOLED REACTOR Na-2. Gast, K.; Schlechtendahl, E. G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translated from report KFK-660. 377p. (EUR-3706). Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The conceptual design description and drawings for the 300 MW(e) fast liquid sodium-cooled Na-2 reactor are presented. Performance requirements and operations criteria are described. (D.C.C.)

37440 (HN-192) ANTISEISMIC DESIGN OF A PWR NUCLEAR POWER STATION. Duncan, J. M.; Gekler, W. C.;

Kennedy, R. P.; Kwan, L. T.; Shimizu, B.; Williamson, R. A.; Wilson, J. H. (Holmes and Narver, Inc., Los Angeles, Calif. Nuclear Div.). Apr. 1968. Contract W-7405-eng-26; Subcontract 2957. 299p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

Effects of seismic loadings on nuclear power stations are evaluated. Modes of stress initiation and structural response are discussed; design considerations are tabulated. The vital systems of nuclear power plants are defined; systems are classified for a typical pressurized water reactor (PWR) design. Detailed failure effect analyses are given for: the safety injection system, containment spray, steam system, containment ventilation, isolation valve seal water, containment penetration pressurization, auxiliary electrical system, and fuel handling system. Effects of penetrations are analyzed; penetrations are tabulated. A prototype containment system is described; loading criteria are established. Effects of faulting on embedded concrete are evaluated. Soil resistance to horizontal displacement is considered. Containment wall design for horizontal displacement resistance is described. Design of the base slab for faulting resistance is detailed; the concept of design of isolated containment walls is considered. A cost analysis of designs for containment systems is given; unit costs are tabulated; costs of isolation features are listed. Appendices include: Analysis of Containment for Horizontal Faulting, Yield Line Analysis of Base Slab Subjected to Diametral Vertical Faulting, Yield Reserve Margin of Piping Systems, Isolation Materials, Resistance of Soil to Horizontal Displacement, Effect of Soil on Dynamic Behavior of Reactor Containment, and Out-of-Plane Shear Capacity of Reinforced Concrete Members Subjected to Axial Tension. 50 references. (M.L.S.)

37441 (HPR-97) COMPARATIVE STUDIES OF MATHEMATICAL HYDRODYNAMIC MODELS APPLIED TO SELECTED BOILING CHANNEL EXPERIMENTS. Bjoerlo, T.; Eurola, T.; Grumbach, R.; Hansson, P.; Olsen, A.; Rasmussen, J.; Romslo, K. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Dec. 1967. 317p. Dep.

Mathematical models to investigate the dynamic behavior of boiling water channels connect the basic laws of conservation of mass, momentum, and energy to empirical correlations for friction, slip ratio, subcooled boiling and heat transfer. Several different approaches are possible in assembling a theoretical model, and comparative studies have been undertaken in which various models were applied to selected experimental conditions. The comparisons between theoretical and experimental results have enabled conclusions to be drawn about the range of applicability of certain physical concepts and given the basis for a better understanding of the importance of several hydraulic parameters in the dynamic behavior of the coolant in a boiling channel. The comparisons between theoretical and experimental results included axial void distribution, void and mass flow in natural circulation as functions of the channel power, transfer functions, and stability limits. Furthermore, the models were compared to each other with respect to the mathematical description and the solution methods. A survey of the available experimental material was carried out which, together with the experience from the model studies, may serve as a guideline for future experiments in this field. (auth)

37442 (HPR-98) POST IRRADIATION EXAMINATION OF THE BURN-OUT ASSEMBLY IFA-38. Videm, Ketil; Hanevik, Amund; Hansen, Reidar A.; Lunde, Knut (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). May 1968. 28p. Dep.

The results from the post irradiation examination of the failed burn-out detector assembly IFA-38 are presented. The failure was caused by diffusion of Inconel into the Zircaloy cladding. This lowered the melting point to about 940°C. It is estimated that the cladding reached about 1010°C during burn-out and failed because of melting of the Zircaloy-Inconel alloy. The origin of the Inconel is the sheath on the burn-out detector cables. No hydride phase was found metallographically in and near the failure area. An area with severe hydriding, having lead to extensive circumferential cracking of the cladding, was found 20 mm away from the failure. The distribution and orientation of the hydride phase was typical for reactions initiated when steam and water are present on the inside of the cladding. This is a secondary effect. Despite the high cladding temperatures, the UO_2 structure indicates a maximum center temperature of no more than about 1700°C. The unautoclaved Zircaloy-2 components behaved very satisfactorily. Unheated parts were little affected, more highly rated parts were coated with a thin, black oxide film. (auth)

37443 (ITN/RF-1.1.1) STUDI DI PROGETTO DEL GENERATORE E DEL CIRCUITO DI VAPORE PER CENTRALI DA 330 E 1000 MWe DOTATE DI REATTORI VELOCI A SODIO. (Design Study of Steam Generator and Loop of 330 and 1000 MW(e) Sodium-Cooled Fast Reactors). (Ansaldo S.p.A., Genoa (Italy)). [1966]. 322p. (In Italian). (ARV-(66)-48). Dep.

General descriptions of the various types of steam generators used in sodium-cooled reactors are given. Schematics are included for: EBR-1, EBR-2, DFR, SRE, HNPF, and EFFBR. Modular unit steam generators are evaluated; advantages and disadvantages are analyzed. The requirements and operating conditions for steam generators for 330 and 1000 MWe nuclear power plants are detailed; data are tabulated. Cooling system and heat transfer data for sodium-cooled power reactors are evaluated; data tabulations and schematics are shown. Preliminary cost estimates for a 150 MWt model steam generator are given. Temperature profiles for the various heat exchange systems are shown. Calculational methods for determining thermal and mechanical properties of the steam generator are described; a complete heat transfer analysis is given; stability analyses are included. Startup of the unit is described; procedures are given. Materials for fabrication and quality control are discussed; fabrication procedures are given. Mechanisms utilized in the control of potential metal–water reactions due to leaks are described. Effects of corrosion products and process water quality control are considered. Design drawings for the units which are evaluated above are included. 37 references. (M.L.S.)

37444 (KFK-665) ZUR ENTWICKLUNG EINES VOLLHYDRAULISCH BETRIEBENEN UND GESTEUERTEN REGEL- UND ABSCHALTSYSTEMS FUER WASSER- BZW. DAMPFGEKUEHLTE KERNREAKTOREN. (On the Evolution of a Completely Hydraulic Driven and Controlled Control and Shut-Off System for Water or Steam Cooled Nuclear Reactors). Muehlhaeuser, O. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Nov. 1967. 40p. (In German). (EUR-3699). Dep.

A general discussion of the development of completely hydraulic drives for control rods is given. The various components are described; these are: a hydraulic reciprocating motor for the control rod, a hydraulic potentiometer, automatic control devices, servo-piston, rachet brake, position recorder, cut-off valve, and recovery and damping springs. Schematics of the components and systems are shown. (M.L.S.)

37445 (KFK-800) ON MODERN SAFEGUARD IN THE FIELD OF PEACEFUL APPLICATION OF NUCLEAR ENERGY. I. BASIC CONSIDERATIONS. II. PREPARATIONAL CONSIDERATIONS FOR A SYSTEM ANALYSIS. Gmelin, W.; Gupta, D.; Haefele, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). May 1968. 38p. Dep.

The functions of nuclear safeguards are broadly defined; scope is outlined. Nine proposed standards for an international nuclear safeguards system are outlined. A systems approach to the development of the system is detailed. 11 references. (M.L.S.)

37446 (MIT-2073-6(Vol.1)) THE EFFECT OF ^{236}U AND ^{237}Np ON THE VALUE OF URANIUM AS FEED FOR PRESSURIZED WATER POWER REACTORS. Goellner, D. A.; Benedict, M.; Mason, E. A. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Dec. 1967. Contract AT(30-1)-2073. 248p. (MITNE-90(Vol.1)). Dep. CFSTI.

Until now U fuel for power reactors has consisted principally of the naturally occurring isotopes ^{235}U and ^{238}U. This fuel has contained so little reactor-produced ^{236}U that it has been possible to establish a price scale based only on its ^{235}U content. In the future, however, U fuel for power reactors may contain significant amounts of ^{236}U, and it will be necessary to take the ^{236}U content into account in determining the value of the fuel. The major economic effects of ^{236}U in fuel charged to a reactor are as a thermal neutron poison and as a target for the production of ^{237}Np, with the relative importance of the two effects being governed by the unit price at which byproduct ^{237}Np can be sold. The purpose of this study is to develop procedures for determining the unit value of U over wide ranges of isotopic compositions and ^{237}Np prices and to apply the procedures to the case where the U is used as feed for typical pressurized water reactor (PWR) fuel flow schemes. The San Onofre PWR is used as the reference reactor. Two U recycle schemes are considered, both of which are examined only under steady-state recycling conditions. In one scheme, recycled U is reenriched by blending with U feed having high ^{235}U content, while the other scheme involves the re-enrichment of recycled U in a gaseous diffusion plant prior to mixing it with the requisite low-enrichment feed U. Steady-state operating characteristics for the reactor and recycle flowsheets were calculated over ranges of feed isotopic compositions using the codes CELL and MOVE, the latter modified to simulate scatter refueling of the reactor. The effect of ^{236}U on separative work requirements and the distribution of ^{236}U in diffusion plant product

and tails streams are considered in detail. The value of feed U having a given isotopic composition and used for a particular fuel flow scheme is determined by requiring that the fuel cycle cost using this feed U be equal to the lowest fuel cycle cost which can be obtained for the same fuel flow scheme when feed U contains no ^{236}U and is priced on the AEC scale. In addition to the basic recycle modes of operation, wherein feed U is sent, as purchased, to the fabrication plant, the unit value of feed U is also calculated for the case where feed is pre-enriched prior to fabrication and for the case where feed is blended with natural U prior to fabrication. In addition to the effects of isotopic composition, operating mode, and ^{237}Np price, the effects on unit feed value of changing natural U_3O_8 price, unit costs of fabrication and reprocessing, and irrecoverable losses during fabrication are also examined. Two definitions of a ^{236}U penalty, in dollars per gram of ^{236}U, are investigated in an attempt to correlate the feed value results and present the ^{236}U and ^{237}Np effects in more tractable form. (auth)

37447 (MIT-2073-6(Vol.2)) THE EFFECT OF ^{236}U AND ^{237}Np ON THE VALUE OF URANIUM AS FEED FOR PRESSURIZED WATER POWER REACTORS. Appendices. Goellner, D. A.; Benedict, M.; Mason, E. A. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Dec. 1967. Contract AT(30-1)-2073. 144p. (MITNE-90(Vol.2)). Dep. CFSTI.

Appendices containing basic data used to develop procedures for determining the unit value of U over wide ranges of isotopic compositions and ^{237}NP prices and in applying these procedures to the use of U as feed for pressurized water reactor fuel cycles are presented. The MOVE code is used to calculate reactivity and flux distribution changes during fuel irradiation. Modifications of the code to simulate scatter refueling of the reactor are described. (H.D.R.)

37448 (NP-17521) FAST BREEDER REACTOR REPORT. Publication No. 68-28. (Edison Electric Inst., New York). Apr. 1968. 82p.

Topics discussed include: economics of fast breeder reactors; evolution of fast breeder reactor programs; fast breeder reactor technology; and participation of the electric utility industry. (D.C.C.)

37449 (ORNL-TM-2132) FLYWHEEL-AUGMENTED FLOW COASTDOWN FOR THE 3500 Mwt, UNCLAD, METAL-FUELED FBR (UMBR). Wichner, R. P. (Oak Ridge National Lab., Tenn.). July 1968. Contract W-7405-eng-26. 37p. Dep. CFSTI.

Equations are presented for the coastdown flowrate in a loop following pump power failure which include the effects of diminishing pump efficiency during coastdown and the retarding torque of the thrust bearings on the pump rotation rate. The bearings are assumed to be of the Kingsbury type with eight, square shoes. Results are given for the primary coolant loop of the 3500 MW(t), sodium-cooled, bare-metal, FBR, for cases utilizing light weight (15,000 kg), medium (60,000 kg), and heavy (240,000 kg) flywheels with 6 m diameter. It is shown that the useful coastdown duration lasts 15 seconds with no added flywheel, and about a factor of 30 increase is attained by adding the light flywheel to each of the primary pump motors. The medium weight flywheels could increase the useful coastdown duration to 2100 seconds, while the heavy flywheels resulted in coastdowns ranging from 6000 seconds to 8100 seconds, depending on the bearing design. In all cases investigated the loss of pump efficiency during coastdown had a much larger effect than that of the thrust bearing retarding torque. Thrust bearing design was found to appreciably affect the useful coastdown duration only for the "heavy" flywheel cases where a 25% range was obtained between the lightest and heaviest bearing loadings. (auth)

37450 (WCAP-7170) DESCRIPTION WESTINGHOUSE REACTOR OPERATOR TRAINING PROGRAM. Schuman, S. D. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Feb. 1968. 45p.

A complete description of the Westinghouse reactor operator training program is given. Training schedules, personnel requirements, and detailed curriculum outlines are tabulated. The curriculum includes classroom, plant operations, and on-site outlines and schedules. (M.L.S.)

37451 THE DEVELOPMENT OF NUCLEAR POWER IN EUROPE DURING 1967. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 70, 95-105(Mar.-Apr. 1968). (In French).

A survey of nuclear-produced electric power in Europe during 1967 is given. Summaries are presented for the following countries: Belgium, Denmark, Federal Republic of Germany, Spain, France, Italy, Netherlands, Norway, Austria, Switzerland, Sweden, and the United Kingdom. (M.L.S.)

37452 TWO YEARS OF OPERATION OF EDF-1 OF CHINON, 1966-1967. Cordier, R.; Simon, H. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 70, 31-7(Mar.-Apr. 1968). (In French).

An operations history of the EDF-1 is given for 1966 and 1967. Some operating characteristics are listed. Operations problems with the primary heat exchanger are summarized; operation and maintenance of the primary blower motor are discussed; methods for measuring the exit temperature of the CO_2 coolant are described. Fuel element design and loading are discussed. (M.L.S.)

37453 STEAM TURBINES FOR NUCLEAR POWER PLANTS. Hossli, W. (Brown, Boveri and Cie., Baden, Switzerland). Neue Tech., 10: 65-72(Apr. 1968). (In German).

The most important turbine problems relating to the current reactor types are dealt with. Blade and leakage erosion, cycle peculiarities, dimensional problems as a consequence of the large steam volumes, governing questions, corrosive attack, etc. are discussed. Two typical examples are mentioned: Beznau and D. C. Cook. (auth)

37454 IMPORTANT STEAM GENERATOR TYPES IN NUCLEAR POWER PLANTS WITH INDIRECT CYCLE. Kaegi, J. (Sulzer AG, Winterthur, Switzerland). Neue Tech., 10: 57-64 (Apr. 1968). (In German).

Following the heating surface arrangement, the classification of the steam generators is divided into helix steam generators, meander steam generators, straight tube steam generators, and U-tube steam generators. The various types are briefly described, whereupon the application in nuclear power stations is shown by examples. The specific steam generator data for the various reactor types are shown for comparison purpose. The quick increase in the unit outputs in general as well as the problem of steam production in fast reactors present the steam generator designer with considerable tasks in the future. (auth)

37455 PRESTRESSED CONCRETE VESSELS FOR NUCLEAR REACTOR CONSTRUCTION. Lafitte, R. (Bonnard and Gardel, Lausanne, Switzerland). Neue Tech., 10: 49-56(Apr. 1968). (In French).

After a brief history of the construction of prestressed concrete vessels for nuclear reactors and a review of the reasons for their development, some problems that set up the concept of their fabrication are examined. General considerations on the shape of the vessel are followed by an analysis of the behavior of the structure and the calculational methods. Dimensional criteria are set up, the problems related to optimization, in particular, the strength of the concrete, and the thermal gradient through the vessel walls are examined. (tr-auth)

37456 INFORMATION SESSION ON THE CAPABILITY OF INDUSTRY FOR THE CONSTRUCTION OF NUCLEAR POWER STATIONS AND ON NUCLEAR TECHNICAL REQUIREMENTS. Mueller, W. (Sulzer AG, Winterthur, Switzerland). Neue Tech., 10: 39-48(Apr. 1968). (In German).

The Swiss industry is technically, and from the point of view of facilities, in a position to manufacture steel structures for nuclear power stations. Reference is made to the installations for the Beznau and Mühleberg plants and to other relevant work in the field of high-pressure vessels, pressure pipes and general welded constructions. It is not the quality required for the constructions that present the difficulties involved but rather the unusual method of handling the orders according to American planning and control. With the aid of the examples of the Mühleberg reactor vessel and the Beznau and Mühleberg safety vessels, the respective technical and organization requirements are illustrated. Concerning the resistance to brittle fracture of buildings, attention is drawn to the danger which heavy-walled structures entail. The use of high-quality heat-treated steels and/or the manufacture of multishell vessels reduces the danger of brittle fracture. (auth)

37457 PHENIX. Rozenholc., M. (CEA, Paris). Energ. Nucl. (Paris), 10: 65-75(Mar.-Apr. 1968). (In French).

The principal features of the fast breeder sodium-cooled Phenix reactor are described. The overall plant layout is illustrated, and design characteristics of the fuel elements, core, control elements, fuel loading machine, steam generator, power plant equipment, and control system are discussed. (H.D.R.)

37458 CONTRIBUTION TO THE STUDY OF NUCLEAR STATION PLANNING. THE DETERMINATION OF STEAM EXPANSION LINES. Chaney, H.; Macaire, M.; Raffier, H.; Petitdidier, P. Energ. Nucl. (Paris), 10: 76-84(Mar.-Apr. 1968). (In French).

The systematic optimization calculations of a fixed station project, on the planning of the nuclear stations, have a repetitive aspect and must be done rapidly and with numerical precision. The use of a computer is helpful in obtaining these characteristics. In order to avoid calculating the same expansion line several times at dif-

ferent time intervals, expansion lines were determined only once. Curve networks are obtained which take into consideration the irreversibilities due to the real characteristics of the steam as well as the machines. It is proposed to adapt to the computer the curve networks presented. (auth)

37459 STOCHASTIC APPROACH TO THE EQUATION OF POWER REACTOR KINETICS. Barrett, P. R.; Thompson, J. J. (Univ. of New South Wales, Kensington, Australia). Energ. Nucl. (Milan), 15: 461-72(July 1968).

The basic equation for the joint probability density required to describe space, time and energy dependent neutron populations, and space and time dependent temperatures, is derived for a model of a heterogeneous power reactor with a constant velocity single phase coolant. γ heating and the fine scale structure of coolant turbulence are not included. From the probability density equation, the usual equations of integral transport theory neutron kinetics, heat conduction and coolant heat transport are deduced. (auth)

37460 TECHNICAL AND ECONOMIC ASPECTS OF NUCLEAR POWER PLANTS EQUIPPED WITH VARIOUS TYPES OF REACTORS. Baumier, M. J. (Commissariat a l'Energie Atomique, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 70, 5-30(Mar.-Apr. 1968). (In French).

Economic and technical aspects of the various types of reactors for nuclear power stations are evaluated briefly. The types of reactors include: gas-cooled graphite-moderated natural uranium-fueled reactors, gas-cooled heavy water-moderated natural uranium reactors, light water-cooled and -moderated enriched uranium reactors, and sodium-cooled fast reactors, comparisons of operating parameters and cost/kwh are tabulated. 37 references. (M.L.S.)

37461 ECONOMIC CONSIDERATIONS ON THE DEVELOPMENT OF FAST BREEDER REACTORS. Gupta, Nat. D.; Jansen, P.; Seetzen, J. (Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ing.-Tech., 40: 413-24(May 17, 1968). (In German).

The planning of a sodium- and of a steam-cooled fast breeder prototype reactor marks a new stage in the development of power reactors in Europe. Fast breeder nuclear power stations should be working economically in Germany round about 1980. After a survey of the various reactor types, reactor projects, and the uranium requirements in each case, the economic advantages of fast breeder nuclear power plants are outlined. These advantages (low cost of energy generation, independence of uranium-reserves and -converters constructional versatility etc.) permit adaption to prevailing technical and economic circumstances. (auth)

37462 PREPARATION FOR IRRADIATION OF HIGH TEMPERATURE EXOR. Avramito, Maurice; Dupont, Jean. Ind. At., 12: No. 1-2, 53-6(1968). (In French).

Preparation of the EXOR fuel capsules is discussed. Conditions for irradiation in EL-4 are listed. In-pile and out-of-pile parts of the capsule and associated equipment are described. Safety considerations for the EXOR capsules are discussed. (M.L.S.)

37463 THE GPU/AI DEMONSTRATION PLANT. Dieckamp, H. (Atomics International, Canoga Park, Calif.); Roddis, L. H. Nucl. News, 11: 41-50(July 1968).

The conceptual design for the GPU/AI 350 to 500 MW(e) liquid sodium-cooled PuO_2-UO_2-fueled fast breeder reactor is presented. Description of proposed plant control and operation is also presented. Economics of operation are described. (D.C.C.)

37464 INCENTIVES FOR DEVELOPMENT OF FAST BREEDER POWER PLANTS. Beekman, Myron C. (Detroit Edison Co.). Nucl. News, 11: 34-40(July 1968).

Predictions of U. S. electric power requirements by year 2000 are presented. The ability of nuclear power plant development to meet substantial power demands by year 2000 is also predicted. Economics of nuclear plant development are presented. Analysis of capacity factor and availability effects on future nuclear power capabilities is described. The development program for fast breeder reactors is discussed. Fuel cycle costs and power generation costs for fast breeder reactor systems are presented. Economic analysis of nuclear fuel requirements and resonances by year 1990 is presented. (D.C.C.)

37465 NUCLEAR POWER STATION WITH A PRESSURIZED WATER REACTOR. Elettrotecnica, 55: 121(Feb. 1968). (In Italian).

A pressurized-water reactor will be used in the power station to be completed in 1972 in Stade, near Hamburg, on the left bank of the Elbe. A Siemens reactor will be used with a thermal power rating of 1900 MW. It has 157 fuel elements of active length 3 m, constituted of 205 fuel loads and 20 guide tubes. The fuel is 3% ^{235}U with a burn out of 31,500 MWd/t U. The water circulates at 288.5°C to 316.3°C; regulation of flow is described. Heat is transferred to four generators which vaporize water producing 3590 t/hr of saturated vapor at 52 atm/265°C. The turbine with a power of 662 MW at 1500 rpm has a two-flux high-pressure part and two two-part low-pressure parts. Cooling water for the double-flux condensers is 107,000 tons/hr taken from the Elbe. The alternator is at 780 MVA. All pressurized parts are placed within the reactor building, which constitutes a spherical internal unit of 48 m dia and an outer unit of reinforced concrete. (BBB)

37466 NUCLEAR POWER-GENERATION SYSTEM. Yamamoto, Koozaburo (to Fuji Electric Mfg. Co., Ltd.). Japanese Patent 1967-17910. Oct. 17, 1967. Filed Mar. 27, 1961.

A power generation system with a nuclear reactor and a steam heating device is described. The system gives an efficient operation of the plant when the steam heating device is repaired or the load is reduced. The system includes: piping for supplying steam from the reactor directly to the low-pressure turbine through a reducing valve; a piping for returning the condensed water from the low-pressure turbine to the reactor by a condenser and its pump; a feed-water pump operated by a variable motor; a piping connected to the low-pressure turbine for supplying steam, heated by a steam heating device, to the high-pressure turbine, and for supplying the steam from the high-pressure turbine to the low-pressure turbine; stoppage valves installed at the entrance to the steam heating device and at the outlet to the high pressure turbine; and, power generators connected to the high-pressure and the low-pressure turbines. (NSA of Japan)

37467 DEVELOPMENT OF AN ELASTOMER FOR PRESSURIZED CARBON DIOXIDE SEALING PURPOSES. Eudes (CEA, Paris); Langlois; Narcy; Dejeux; Anglade; Moret. Fnerg. Nucl. (Paris), 10: 101-8(Mar.-Apr. 1968). (In French).

Sealing problems involved in EL 4 Reactor have led to the development of an elastomer compatible with high pressure carbon dioxide. Laboratory tests were conducted on most of the elastomers available on the market, and a silicone-ethylene-propylene grafting meeting the operating requirements was developed. As a general rule, the results recorded up to now in actual practice are rather hopeful. However, the weak point of this compound is its low creep resistance, though improved by means of γ radiation. (auth)

37468 DEVICE FOR RELEASING THE PEAK PRESSURE BY A VALVE. Hanada, Kiyoshi (to Nippon Atomic Industries Group Co., Ltd.). Japanese Patent 1967-17911. Oct. 17, 1967. Filed July 13, 1965.

By the method proposed, the peak pressure from the bypass to the boiling reactor, occurring in cutting off the turbines due to the opening of the circuit breaker connected to the generators, can be removed. This leads to the non-shut-down of the reactor. The operation is definite, and simple and low cost. A "peak pressure" release valve is installed in the bypass system. This valve opens for a brief period before the opening of the usual bypass valves to release the initial peak steam to the condenser, and hence to release the peak pressure. (NSA of Japan)

37469 THERMAL DISCHARGES. Kolflat, Tor. Ind. Water Eng., 5: 26-31(Mar. 1968).

Heat discharges from nuclear and other types of thermal power plants are discussed. An estimated projection of the total thermal generating capacity in service through the year 2000 includes fossil, nuclear, and breeder nuclear types of plants. Nuclear plants reject about 50% more heat than fossil plants of similar electrical capability. This is because the use of nuclear fuel dictates a lower steam pressure and consequently a less efficient use of steam resulting in more waste heat. It is expected that future breeder nuclear units will return to a heat rejection equivalent to present-day fossil units. Projections consider all future plants to be nuclear or all fossil. Total heat rejection in the year 2000 then would be increased either 12 to 7 fold, respectively. (BBB)

37470 REACTOR-CONTROL TUBES OPERATED BY THE PRESSURE. Ogura, Narumi (to Mitsubishi Atomic Power Industries Inc.). Japanese Patent 1967-17907. Oct. 17, 1967. Filed Sept. 1, 1964.

The method proposed has the following advantages: a reduction in the number of control elements, the avoidance of the usual driving mechanism, and a resulting reduction of cost. The method can be applied to liquid-moderator reactors. The gas-filled control tubes, the upper end of which is sealed and the bottom end which is open, are arranged appropriately within the liquid moderator in the reactor core. The increase of pressure in the reactor forces liquid moderator into the tubes, through the bottom opening, while pressurizing the gas in the tube. (NSA of Japan)

37471 PLANNING THE USE OF WATER FOR COOLING PURPOSES IN POWER STATIONS. Gammon, M. G. Water Res., 2: 131-6(Jan. 1968).

Studies were carried out on the environmental effects of heat in discharged cooling water at Bradwell Nuclear Power Station

(300 MW) on the unpolluted Blackwater Estuary. The hydrographic investigation showed that the Blackwater Estuary is a vertically homogeneous one, and indicated that thorough mixing takes place in the vicinity of the power station. Rapid cooling was shown to take place due to initial mixing in this locality. Layering was found and occurred because the heated discharge was initially of a lesser density than the water in the estuary. Extensive littoral and benthic surveys were carried out and showed no unnatural ecological fluctuations. (BBB)

37472 REACTORS NOW USE CONCRETE FOR CONTAINMENT. Schupack, Morris. Power, 112: 63-5(July 1968).

The current trend to the use of structural concrete lined with steel for nuclear reactor containment shells is discussed. Concrete properties, steel reinforcement, and construction techniques are described, and design details of concrete containment for U.S. boiling-water and pressurized-water reactors are tabulated. (H.D.R.)

37473 THERMAL-HYDRAULIC DESIGN CALCULATIONS FOR THE BOILING WATER REACTOR OF LINGEN POWER PLANT. Rupp, W. Atomkernenergie, 13: 237-44(1968). (In German).

The principles and methods of design calculations and the principal data for the Lingen boiling water reactor are presented. The definition of thermal-hydraulic design criteria, description of power distribution and critical heat flux limit curves used in design, the calculation of fuel rod temperatures, flow distribution and pressure drops in the core, the choice of the core inlet orificing, the steam separators and finally the evaluation of the recirculation flow control characteristics are presented. (auth)

37474 FUTURE POSSIBILITIES OF THE AMERICAN NATIONAL REACTOR PROGRAM. Starr, C. (Univ. of California, Los Angeles). Energ. Nucl. (Madrid), 12: 15-24(Jan.-Feb. 1968). (In Spanish).

The overall reactor program for the U.S.A. is discussed; the various types of reactors and fuel cycles available are considered. Fuel requirements are projected to the year 2030. The economic inpact of fuel demands is evaluated. Total costs of the various programs are evaluated. (M.L.S.)

37475 NUCLEAR REACTOR. Deliege, Jacques; Gerard, Claude; Maldague, Pierre (to Societe Anglo-Belge Vulcain S. A.). U. S. Patent 3,384,549. May 21, 1968. Priority date Aug. 28, 1964, Luxembourg.

The description of a nuclear reactor is presented. The reactor consists of a pressure vessel, a core, heat exchangers, and mechanisms for actuating hydraulically driven control rods. The heat exchangers are divided in several sections and are located in two regions of the pressure vessel; one region upstream of the circulating pumps and the other region downstream of the circulating pumps. The flow of coolant through the heat exchanger regions creates head losses which are used for actuating control rods and feeding the pressurizer atomization device. (auth)

37476 IMPROVEMENTS IN AND RELATING TO PRESSURISED WATER NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 1,117,829. June 26, 1968. Priority date Dec. 20, 1965, United States.

The description of a pressurized-water reactor is presented. The pressure vessel contains the reactor core and the steam generating and superheating tube bundles. A vertical sleeve encloses the core located near the bottom of the pressure vessel. Between the sleeve and the pressure vessel wall is located the steam generating tube bundle. The water level is maintained to keep the core submerged. (D.C.C.)

37477 K-INFINITY OF FOUR NATURAL URANIUM FUEL MATERIALS IN HEAVY WATER REACTORS. Schludi, H. N.; Whitfield, J. H. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). Atomkernenergie, 13: 257-61(1968).

The infinite multiplication constant, k-infinity, has been calculated using the Methuselah code for a heavy water reactor with a single rod-per-cell lattice. The fuel being considered consists of four different but practically feasible natural uranium fuel materials: oxide, carbide, silicide and metal. It is found that for the practicable range of moderator/uranium atom ratios [$N(D_2O)/N(U)$ between 10 and 40] the reactivity increases with the uranium content densities. These results apply sufficiently accurately to large finite size reactors, and also to reactors having rod cluster fuel elements. The k-infinity is also a sufficient indication to estimate attainable burn-up for preliminary evaluation purposes. An estimate is given of the relative influence of the uranium density effect on k-infinity as compared with that of the respective compounding elements Si, C and O. (auth)

37478 NUCLEAR REACTOR HEAT TRANSFER SYSTEM. Parris, Harold C. (to North American Aviation, Inc.). U. S. Patent 3,374,149. Mar. 19, 1968. Filed May 19, 1967.

A heat transfer system having a superheater, reheater and evaporator heat exchanging modules, each having a primary liquid metal flow path and a secondary fluid flow path, is described. The primary fluid flow paths of the superheater and reheater modules are connected in parallel with each other and in series with the primary fluid flow path of the evaporator module. The secondary fluid flow paths of the superheater, evaporator and reheater modules are connected in series through a turbine. (auth)

37479 MATERIALS FOR LIQUID SODIUM CIRCUITS. Maroto, J.; de Tejada, L. M. Saenz. Energ. Nucl. (Madrid), 55-65(Jan.-Feb. 1968). (In Spanish).

The thermal characteristics of sodium and water coolants for power reactors are tabulated. Effects of reactor environment on stainless, low chrome, and low carbon steels and cobalt and nickel base alloys are considered. The corrosion processes in the coolant circuits are described; chemical reactions and mass transport are detailed. Effects of surface deterioration and surface deposits are discussed; the corrosion resistance of various materials is shown as a function of temperature. Effects of oxygen and other coolant impurities on coolant loop materials are considered. (M.L.S.)

37480 NUCLEAR STEAMPLANT METHOD AND APPARATUS. Hanzalek, Frederick J. (to Combustion Engineering, Inc.). U. S. Patent 3,384,550. May 21, 1968. Filed Dec. 29, 1966.

A nuclear powerplant system to facilitate decay heat removal during shutdown operation is described. The system does not require auxiliary power sources for circulation in a super-critical pressure reactor with a water heating pass and a steam superheating pass. The system consists of a turbine drive feed pump for supplying water to the reactor, a valve in the through-flow path intermediate the water heating and steam heating passes and a flash tank with valved inlet and outlet lines in parallel with the valve, and a valved pipe from the flash tank to the feed pump turbine for driving the feed pump with flash tank steam during decay heat removal and for supplying cooling steam to the superheating pass. (auth)

37481 NUCLEAR POWER PLANT WITH A HETEROGENEOUS REACTOR CORE. Braun, Helmut; Setzwein, Andreas (to Brown Boveri/Krupp Reaktorbau GmbH.). British Patent 1,117,736. June 26, 1968. Filed May 25, 1966.

The description of a heterogeneous reactor with water and gas coolant channels is presented. The water coolant flows directly through the core, and the gas coolant flows in a jacket around the core. The coolants are mixed as they exit the reactor and the gas coolant serves to superheat the vaporized water coolant. The coolant mixture is exhausted into a turbine and then a condenser for reclaiming the coolants. (D.C.C.)

37482 REACTOR PUMPING SYSTEM. Roberts, John Martin (to General Electric Co.). U. S. Patent 3,380,649. Apr. 30, 1968. Filed Oct. 19, 1965.

A feedwater driven jet pump system for circulating the coolant fluid in a nuclear reactor is described. The feedwater driving fluid and the driven coolant fluid are directed through a heat exchanger so that the driving fluid cools the driven fluid to prevent it from flashing into steam at the pump inlet. Two jet pumps are arranged in series so that each pump operates at a lower mass flow ratio to reduce sensitivity of flow rate to pressure variations across the reactor core. (auth)

37483 PROBLEMS OF SURVEILLANCE TEST PROGRAMS IN THE REACTOR PRESSURE VESSEL. Fujimura, Tadato. Nippon Genshiryoku Gakkaishi, 10: 337-42(1968). (In Japanese).

Problems pertaining to the surveillance tests and the results of tests performed on the JPDR (Japan Power Demonstration Reactor) are presented. Comparison is made with corresponding procedures applied to the Yankee, SM-1 and Dresden Reactors. (auth)

37484 INTEGRAL-TYPE NUCLEAR SUPERHEATING REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1967-19541. Oct. 2, 1967. Filed Dec. 1, 1964.

The method proposed has the following advantages: simplification of the construction of the type of reactor; elimination of the obstruction of fuel exchange by control rods; and efficient operation of the reactor. The reactor consists of a central steam superheating region and an outer water boiling region. In the outer boiling region, space is provided just inside the pressure-vessel wall and outside the wall of the central superheating region for both the coolant downward-flow and the insertion of control rods entering the reactor from the bottom. (NSA of Japan)

37485 NUCLEAR REACTOR. Kanai, Tsutomu (to Hitachi Ltd.). Japanese Patent 1967-19545. Oct. 2, 1967. Filed Apr. 30, 1965.

A water-cooled reactor with heavy water-moderator and water-coolant gives the following: flattening of the power output distribution, steady long-period control of the reactivity, and easy control. Part of the moderator water is taken out of the reactor, and its temperature is changed. By returning this moderator to the reactor, moderator regions of different temperatures are obtained in the reactor. The reactor includes: the reactor core containing fuel and moderator; the containment vessel; a means for circulating coolant-water through the reactor core out of contact with the moderator; a means for extracting heat from the coolant water; a means for taking part of the moderator out of the reactor; a means for giving a temperature change to the removed moderator; and a means for distributing the temperature-changed moderator to each moderator region. (NSA of Japan)

37486 NUCLEAR REACTOR. Kanai, Tsutomu (to Hitachi Ltd.). Japanese Patent 1967-15500. Aug. 26, 1967. Filed May 17, 1965.

The nuclear reactor proposed has the following advantages: compactness of the reactor core, increase of the power density, increase of the conversion ratio, and stabilization of the reactor core of positive power coefficient. The reactor consists of the reactor core which has a positive power-coefficient central region and a region with a sufficiently small volume-ratio of moderator and fuel to make negative the over-all power coefficient with light-water moderator; the containment vessel; and a means to remove the heat output from the reactor core. (NSA of Japan)

37487 DEVICE FOR ADJUSTING THE REACTIVITY OF NUCLEAR-SUPERHEATING TYPE REACTORS. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1967-17906. Oct. 17, 1967. Filed Oct. 7, 1964.

The method proposed has the following advantages: compactness and simplicity of the reactor structure, and effective adjustment of the reactivity. In the superheating type reactor, the middle of the reactor core is the superheating region, and the outer region is the boiling region. Between these two regions is provided an annular-in-cross-section space formed by metal plates. Outside of the reactor pressure-vessel, a drum, containing a neutron-absorbing liquid, is installed. The annular space in the reactor core is connected to the drum by two pipes; one pipe runs from top of the space to top of the drum, and the other pipe from bottom to bottom. Neutron-absorbing liquid in the drum is led to the annular space in the reactor core through the "bottom" pipe. An inert gas fills the upper part of the annular space and the drum, and the "top" pipe. A pump is installed in the "bottom" pipe and also a bypass is set nearby below the drum. (NSA of Japan)

37488 NUCLEAR REACTOR AND ITS COOLING METHOD. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1967-15503. Aug. 26, 1967. Filed Apr. 16, 1964.

The method described provides a "high economy" power reactor in which the cooling of the reactor core is improved with a relatively small amount of heavy water. The reactor pressure vessel contains a central cylindrical body at the bottom of which is located the reactor core. The outer space between the pressure vessel and this cylindrical body contains the heat exchange system with multiple tubes. Heavy water (primary coolant) enters the reactor core at the bottom, rises through the central cylindrical body, comes down through the outer space, and again enters the reactor core. Through the heat-exchange tubes flows light water (secondary coolant), the produced steam being sent to the turbines. The level of heavy water in the outer space is maintained higher than that in the central cylindrical body by establishing a flow resistance near the entrance to the reactor core. (NSA of Japan)

37489 STEAM–WATER SEPARATOR FOR A NUCLEAR REACTOR. Aizu, Tadashi (to Hitachi Ltd.). Japanese Patent 1967-15929. Sept. 13, 1967. Filed Feb. 4, 1965.

The steam–water separator proposed has the following advantages: simple construction, obtaining of high-quality highly dried steam, suitability for installation in the reactor due to its relatively small size, and possibility of using large "meshes." A steam heater is installed within the steam–water separator in the reactor pressure-vessel in order to increase the dryness of steam. (NSA of Japan)

37490 DEVICE FOR RELEASING THE PRESSURE AT THE TIME OF AN ACCIDENT IN A NUCLEAR-SUPERHEATING TYPE REACTOR PLANT. Takashima, Yoshie (to Hitachi Ltd.). Japanese Patent 1967-15504. Aug. 26, 1967. Filed July 5, 1965.

In a nuclear-superheating type reactor plant, when a rupture occurs in the superheated-steam piping to the turbines, water in the boiling region in the reactor tends to enter the central superheating region causing the increase of nuclear reactivity in the superheating region. By the device proposed, the pressure in the boiling region is released. Outside the reactor pressure-vessel, a pressure-release valve is installed which connects to the heated saturated steam room above the superheating region and to the superheated steam piping; to this valve is also connected an "outward" pressure-releasing pipe. In normal operation of the reactor the "valve" is closed, but, when a rupture occurs, it is opened to release the pressure by means of the pressure difference between one side and the other side of the valve. (NSA of Japan)

37491 IMPROVEMENTS IN AND RELATING TO GAS-COOLED NUCLEAR REACTORS. Bennett, John Charles (to Atomic Power Constructions Ltd.). British Patent 1,113,145. May 8, 1968. Filed Dec. 14, 1966.

The description of a gas-cooled reactor is presented. The reactor consists of a pressure vessel, an inverted cup-shaped biological shield within the pressure vessel, a graphite-moderated core within the shield, a core support, heat exchangers located inside the pressure vessel and outside of the shield, and a gas coolant pump. The coolant is forced upward through the core and downward through the heat exchangers. Part of the gas coolant passes through the biological shield and then downward around the graphite cylinders. (D.C.C.)

37492 IMPROVEMENTS IN NUCLEAR REACTORS. Shaw, James William Westgarth (to United Kingdom Atomic Energy Authority). British Patent 1,115,292. May 29, 1968. Filed Mar. 25, 1966.

The description of an integral gas-cooled reactor is presented. The reactor system consists of concrete pressure vessel-enclosed core and heat exchanger. The heat exchanger contains parallel flow paths for a secondary cooling system which passes outside the pressure vessel. The flow paths can be regulated individually. The secondary cooling system has dome-shaped seals at the pressure vessel exits. (D.C.C.)

37493 IMPROVEMENTS IN NUCLEAR REACTORS. (to Babcock and Wilcox Ltd.). British Patent 1,115,354. May 29, 1968. Priority date Aug. 11, 1964, Germany.

The description of a pressurized-water and steam-cooled reactor is presented. Part of the core is water-cooled and delivers steam generating heat to a barrier-separated space above the core. The steam generated in the separated space is circulated through the intermediate and central core regions. (D.C.C.)

37494 LIQUID COOLED NUCLEAR REACTOR. Deighton, Thomas (to Babcock and Wilcox Ltd.). U. S. Patent 3,383,288. May 14, 1968. Priority date Nov. 10, 1964, Great Britain.

The description of a pressurized-water nuclear reactor is presented. The reactor consists of a reactor vessel containing a reactor core, a heat exchanger, and water coolant. The liquid coolant is circulated through the core and heat exchanger by a pump which discharges the coolant through a jet nozzle to increase circulation rate of coolant. (auth)

37495 MEANS FOR CONTROLLING THE FLOW OF HEAT THROUGH WALLS. Bilsborough, Roy; O'Tallamhain, Colm (Nuclear Power Plant Co., Ltd. AEI-John Thompson Nuclear Energy Co., Ltd.). British Patent 1,115,263. May 29, 1968. Filed Oct. 8, 1965.

The description of a thermal insulation system for a boiling reactor concrete pressure vessel is presented. The insulation system consists of a solid material with sub-layers and passages formed between the insulation and pressure vessel wall. Water coolant is forced through the insulation passages to cool the pressure vessel wall surface. (D.C.C.)

37496 IMPROVEMENTS IN AND RELATING TO TUBULAR HEAT EXCHANGERS. (to Waagner-Biro Aktiengesellschaft). British Patent 1,109,669. Apr. 10, 1968. Priority date May 20, 1964, Austria.

The description of a heat exchanger for a gas-cooled nuclear reactor is presented. The heat exchanger consists of multiple sections of concentric cylinders with increasing diameters. Each section contains groups of helically coiled tubes of uniform diameter. The axial lengths of the helical coils of tubes are equal in the direction of the heat exchanger axis. The helix angle of the tube coils decreases as the cylinder diameters increase. The number of turns of the helically coiled tubes decreases with increasing cylinder diameter, and the number of tubes in each cylinder decreases with increasing cylinder diameter. (D.C.C.)

37497 NUCLEAR REACTOR COOLANT PURIFICATION. (to U. S. Atomic Energy Commission). British Patent 1,115,815. May 29, 1968. Priority date Aug. 14, 1964, United States.

The description of a fission product filtering system for a gas-

cooled reactor coolant is presented. The system consists of multiple heat exchangers with absorbent portions. The absorbent portions consist of activated charcoal of high xenon absorption capacity. (D.C.C.)

37498 IMPROVEMENTS IN NUCLEAR ENERGY PLANT. Chicken, John Charles (to United Kingdom Atomic Energy Authority). British Patent 1,115,278. May 29, 1968. Filed Mar. 25, 1966.

The description of a glass filament containment structure for steam drums and pressurized-water reactor pressure vessels is presented. The resin bonded glass filament structures provide thermal logging and biological shielding as well as safety containment. (D.C.C.)

37499 NUCLEAR PLANT TRAINING. Guppy, W. H. (Commonwealth Edison Co., Chicago); Masche, G. C. Power Eng., 72: No. 7, 38-41(July 1968).

A general description of the BWR training center, located at Dresden, is given. The training program, the console and facility, and operator requirements are described. The programmed simulator malfunctions are listed. (M.L.S.)

37500 DESIGN ON THE LINGEN REACTOR. Engel, H. Atomkernenergie, 13: 153-60(May-June 1968). (In German).

The Reactor Lingen was first critical on 1-31-68. Thus one of the two first "commercial and almost German" Nuclear Power Plants is just before starting full power operation. The design of the nuclear part is discussed in detail. A short description of the whole plant and, in more detail, differences between the KRB- and KWL-reactor and related developments are presented. Three detailed design papers refer to nuclear, thermal-hydraulic and dynamic reactor design. It is planned to present the experiences gained during start up and first power operation at the end of the year. (auth)

37501 NUCLEAR DESIGN OF THE BOILING WATER REACTOR FOR THE KERNKRAFTWERK LINGEN. Schulze, J.; Wolff, U. (AEG-Telefunken, Frankfurt am Main). Atomkernenergie, 13: 161-70(May-June 1968). (In German).

Criteria and data of the nuclear core design of the KWL-reactor are given. Starting from a brief discussion of the basic nuclear methods of calculation and from an experimental verification of those, the core design with respect to reactivities, power distributions and burn up-behaviour is described. Finally the design of the various nuclear instrumentation systems is presented. (auth)

37502 DOES THE IMPORT OF NUCLEAR FUELS CONSUME TOO MUCH FOREIGN CURRENCY. Finke, W. Atomwirt. Atomtech., 5: 241-2(May 1968). (In German).

Among the arguments which are still advanced today in the German Federal Republic against the introduction of nuclear energy for the large scale generation of electricity is the contention that the provisioning of nuclear power stations with nuclear fuel represents a burden on the balance of payments. Power stations should therefore give preference to indigenous fuels. Such an argument overlooks the fact that other fuels, e.g., oil and American coal, require much more foreign currency. In addition it ignores the indirect loading of the balance of payments which arises because the use of more expensive indigenous fuels inflates energy costs and so handicaps the export potential of those branches of industry which use a lot of power. In addition internal cost increases lead to higher imports. Nuclear power stations and the supplies connected with them also play a large role in the case of exports and in future this area will have an ever increasing share in the overall export of power stations. Finally the important economic aim is not a surplus of foreign currency anyway but a well adjusted balance of trade. (auth)

37503 ENGINEERING PROBLEMS OF TURBOMACHINERY AND HEAT TRANSFER EQUIPMENT FOR NUCLEAR MHD POWER PLANTS. Foerster, S.; Gilli, P. V. (Kernforschungsanlage, Juelich, Ger. Kernenergieabteilung, Vienna). Atomkernenergie, 13: 205-22(May-June 1968).

Problems of lay-out, design, materials, arrangement, cost and optimization of turbomachinery and heat transfer equipment in future nuclear MHD power plants with various flow sheets are discussed. It is concluded that particularly seed compatibility (and seed separation) require further investigation. An example for a 1000 MW(e) plant of the pure regenerative type with neon as working medium is carried out. Making certain assumptions about basic lay-out data and financial ground rules, it is shown that the economic temperature difference in the regenerative heat exchanger is considerably larger than had been assumed so far. (auth)

37504 MIX OF WATER AND BREEDER REACTORS CUTS FUEL COST. Webb, Ralph A. Jr. (Babcock and Wilcox Co., Lynchburg, Va.). Elec. World, 168: 24-6(Oct. 9, 1967).

Development plans for U. S. LWR systems, FBR systems, and LWR/FBR combination systems are presented. Analysis of fuel costs and doubling time efficiency is graphically represented. Design parameters for a conceptual 1000 MW(e) LMFBR are listed. (D.C.C.)

37505 PROPOSALS FOR IMPROVING THE LICENSING PROCEDURE REQUIRED BY THE ATOMIC LAW. Franzen, L. F. Atomwirt. Atomtech., 10: 261-3(May 1968). (In German).

In the German Federal Republic, as in other countries, consideration is being given to a reform of the licensing procedures for nuclear energy installations. At a panel discussion of the Institute for Reactor Safety (IRS) in which representatives of industry, the authorities, and research took part the reforms were discussed. There was agreement that in the past difficulties had been overcome mainly through the pragmatic attitude of all the participants. For the future there was particularly a desire for greater certainty that a state of affairs when once licensed could not be opposed again through a later trend in the licensing procedures. To achieve this certain changes are necessary in respect to the possibility of licensing a site and in respect to the termination of the building license. In contrast the question of changes in the safety report remained in the background. A type licensing would be desirable for reactors of a proven type but at the moment the requirements for this are apparently still not granted. At the suggestion of the Ministry of Research German criteria in accordance with the new safety criteria of the USAEC are also being worked out by the IRS. More strongly worded technical rules for nuclear energy installations are also to be worked out in collaboration with industry. These must however be flexible enough to take account of the still rapidly advancing nuclear technology. (auth)

37506 THE USE OF THORIUM IN HEAVY WATER MODERATED REACTORS. PROSPECTS AFTER THE 1967 IAEA SYMPOSIUM ON D_2O POWER REACTORS. Graziani, G.; Rinaldini, C.; Zanantoni, C. (EURATOM-CCR, Ispra, Italy). Energ. Nucl. (Milan), 15: 373-80(June 1968).

A brief review of recent work on thorium fuel-cycles in heavy water moderated reactors is presented with a view to showing that the majority of authors are pessimistic about the economics of thorium fuel-cycles. The reasons why thorium is not, and probably will not be, competitive with uranium are discussed, taking as an example a fuel-cycle analysis carried out for a pressurized heavy water reactor The fuel-cycle optimization is performed for a set of economic parameters such as the cost of the uranium ore, the reprocessing and fabrication cost, the enrichment cost. The conclusion is drawn that an increase of the uranium ore cost is not enough to make thorium competitive against uranium. Only a large increase of the uranium ore cost coupled with a large decrease of the isotope-separation cost can make the cost of thorium fuel-cycle lower than that of natural or slightly enriched uranium cycle in heavy water reactors. (auth)

Marine and Portable Power Reactors

37507 (AED-C-22-09) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 22. KERNENERGIEANTRIEBE FUER SCHIFFAHRT. (Bibliographies in Nuclear Science and Technology. Section 22. Nuclear Ship Propulsion). Paro, J. N. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Mar. 1968. 33p. (In English and German). Dep.

A bibliography on nuclear ship propulsion is presented. 105 references from conferences, patents, reports, publications, and books are cited; titles and availabilities are listed. (M.L.S.)

37508 IRRADIATION TEST OF THE PRESSURE VESSEL STEEL OF THE N. S. OTTO HAHN. Ahlf, J. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Hamburg); Florin, C.; Schmelzer, F. Atomkernenergie, 13: 199-204 (May-June 1968). (In German).

After a survey of development and properties of the FDR pressure vessel steel, particularly concerning its brittle fracture behavior, irradiation experiments on impact test specimens taken from this steel and their evaluation, are described. Specimens of the base material and welded specimens have been irradiated at 300°C in FRG-1, the fluence of fast neutrons (E > 0.1 MeV) being about 10^{17}, 10^{18} and 10^{19} n/cm^2 respectively. Up to a fluence of 10^{18} n/cm^2 the impact strength is improved. A decrease, however, of the impact strength below the values of the unirradiated material was found only at the highest neutron dose of about 10^{19} n/cm^2. As the neutron dose received by the FDR pressure vessel throughout its entire operation time is estimated not to exceed 10^{18} n/cm^2, these results indicate that an increase of the danger of brittle fracture due to irradiation effects is not to be expected. (auth)

Rocket and Space Reactors

Refer also to abstracts 35944 and 36455.

37509 (AI-AEC-Memo-12673) NEW CROSS SECTION NEEDS FOR ZIRCONIUM HYDRIDE SNAP REACTORS. Ottewitte, Eric (Atomics International, Canoga Park, Calif.). Apr. 2, 1968. 12p. (CONF-680307-35). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

A zirconium hydride SNAP reactor consists of hydrided rods of U-Zr alloy surrounded by rotatable beryllium reflector drums. The current direction of SNAP reactor designs is toward reliable long-term (1 to 5 years) operation and additional safety features. These designs may require poison-backings on the reflector drums (for some applications) plus a variety of new burnable poisons. Candidate poison-backings include europium and other rare earths as well as B_4C. Both absorption and scattering cross sections are important, particularly in the keV range. Candidate burnable poisons include Gd-157, Sm-149, Cd-113, Gd-155, Hf-177, Ir-191, Eu-151, Dy-162, Sm-152, and Dy-163. The absorption cross sections below 10 eV are particularly important. One of the desired safety features in future zirconium hydride reactors is subcriticality in water in the event of a launch abort. This might be achieved through spectral shift if the burnable poison has a low-lying (below 0.1 eV) resonance. A large number of stable or long-lived isotopes which have not been measured for low-lying resonances are indicated. (auth)

37510 (GA-8390) THERMIONIC REACTORS FOR ELECTRIC PROPULSION: PARAMETRIC STUDIES. Homeyer, W. G.; Heath, C. A.; Gietzen, A. J. (Gulf General Atomic, Inc., San Diego, Calif.). May 20, 1968. Contracts AT(04-3)-167; NAS-3-6471. 20p. (CONF-680508-5). Dep. CFSTI.

From 2nd International Conference on Thermionic Electrical Power Generation, Stresa, Italy.

In-core nuclear thermionic power plants consist of a reactor containing thermionic cells, a nuclear radiation shield, a heat rejection system, and electrical transmission lines and power conditioning equipment. The influence of design parameters on size, mass, and reliability is evaluated over a range in power output from tens of kilowatts to several megawatts. Methods of achieving high reliability with a minimum sacrifice in size and mass are described. The importance of the multiplicity of components and their manner of connection is evaluated. Major parameters of the reactor include the emitter and collector temperatures and electrical power density, and emitter size, the nuclear fuel fraction, and the fissile nuclide. The parameters affecting the shadow-shield mass include the cone angle, the dose rate allowable, and the distance between the reactor and the region to be shielded. For the heat rejection system, the coolant composition, the temperature, and the multiplicity of components (pumped loops and heat pipes) are important factors. Transmission lines are characterized by their composition; temperature and length, and by the voltage output of the reactor. Power conditioning design is based on voltage input and component ratings. (auth)

37511 (LA-3796) LARGE PARTICLES IN THE PHOEBUS 1B EFFLUENT. Fultyn, Robert V. (Los Alamos Scientific Lab., N. Mex.). Dec. 1, 1967. Contract W-7405-eng-36. 26p. Dep. CFSTI.

The efforts directed toward collecting and examining the large particles released by the Phoebus 1 B reactor are described. Successful and unsuccessful collections and evaluation techniques are discussed in detail. Results show that all physical characteristics investigated must be described statistically as variate quantities. (auth)

37512 (N-68-15792) SMALL HIGH-TEMPERATURE NUCLEAR REACTORS FOR SPACE POWER. Lantz, Edward; Mayo, Wendell; Westfall, Robert M.; Anderson, John L. Jr. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 19p. (NASA-TN-D-4371). CFSTI.

As a first step in a comparison of the relative performance of nuclear reactors and of other thermal sources for space power systems, criticality calculations were made for small, cylindrical, lithium-cooled reactors which use tungsten as the structural material. The nuclear fuels considered were ^{239}Pu, ^{233}U, and ^{235}U. These fuels were assumed to be in the form of pure metals, nitrides, and oxides. The radial neutron reflectors considered were beryllium oxide, molybdenum, and carbon. The calculations revealed that the smallest cores are those fueled with metallic ^{235}U and ^{239}Pu. These cores can be as small as 11 centimeters in diameter and 30.5 centimeters long; however, at desired operating temperatures these cores would contain molten fuel. The smallest solid fuel core contains ^{233}U nitride (^{233}UN) in a core 13.5 centimeters in diameter and 30.5 centimeters long. The reactor diameters increase about 2.5 centimeters when the oxide fuel is used in place of the nitride. Cores fueled with ^{235}U are considerably larger than those fueled with ^{233}U. (auth) (STAR)

37513 (N-68-16664) INVESTIGATION OF GASEOUS NUCLEAR ROCKET TECHNOLOGY. Quarterly Progress Report, September 16-December 15, 1967. McLafferty, G. H. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Dec. 30, 1967. Contract NASw-847. 27p. (NASA-CR-92987; F-910093-38; QPR-17). CFSTI.

This investigation covers work in the following technical areas: (1) fuel retention characteristics of a model of a coaxial-flow gaseous nuclear rocket; (2) vortex flow, primarily in an RF-heated vortex, to obtain information for application to a nuclear light bulb reactor; (3) the opacity of seeds which might be employed in gaseous nuclear rockets; (4) in-reactor measurements of the transmission characteristics of transparent materials; and (5) studies of the effect of the results of these investigations on the characteristics of full-scale engines. In the coaxial-flow tests, experiments were conducted to determine the effect of buffer layer velocity and chamber length-to-diameter ratio on containment characteristics. RF vortex tests were conducted to determine the effect of various parameters on the radius of the gas discharge region. Refinements were made in the equipment for measuring gas opacity, including modifications necessary for determining the opacity of uranium gas. Additional tests of transparent materials in a TRIGA reactor were prepared. (auth) (STAR)

37514 (N-68-17131) EXPLORATORY FLOW AND CONTAINMENT EXPERIMENTS IN A DIRECTED-WALL-JET VORTEX TUBE WITH RADIAL OUTFLOW AND MODERATE SUPERIMPOSED AXIAL FLOWS. Interim Summary Technical Report No. 5, September 15, 1965-May 30, 1967. Johnson, Bruce V. (United Aircraft Corp., East Hartford, Conn.). Feb. 1968. Contract NASw-847. 85p. (NASA-CR-992; F-910091-11). CFSTI.

The containment characteristics of confined radial-outflow vortexes with superimposed axial flow were studied to determine whether high average simulated-fuel densities and high ratios of simulated propellant-to-fuel flow rates could be obtained. The experiments concentrated on two factors that influence simulated-fuel containment: (1) simulated-propellant injection methods in which the flow is injected from the peripheral wall of an axial-flow vortex tube with both axial and tangential (circumferential) components of velocity, and (2) simulated-fuel injection methods. Compared with the containment times measured with no axial component of injection velocity, improvements in containment time of as much as a factor of three-and-one-half were obtained in this investigation using injection with both axial and tangential components of velocity. However, the maximum containment times that were measured were approximately one to two orders of magnitude less than the value now estimated to be required for an economically practical, open-cycle gaseous-core nuclear rocket. (auth) (STAR)

37515 (N-68-22038) STUDIES OF SPECIFIC NUCLEAR LIGHT BULB AND OPEN-CYCLE VORTEX STABILIZED GASEOUS NUCLEAR ROCKET ENGINES. McLafferty, G. H.; Bauer, H. E. (United Aircraft Corp., East Hartford, Conn.). Apr. 1968. Contract NASw-847. 102p. (NASA-CR-1030; F-910093-37). CFSTI.

Analytical studies were conducted to determine the characteristics of two specific vortex-stabilized gaseous nuclear rocket engines: a nuclear light bulb engine and an open-cycle engine. Both engines are based on the transfer of energy by thermal radiation from gaseous nuclear fuel suspended in a vortex to seeded hydrogen propellant. The two engines differ in that the nuclear light bulb engine employs an internally-cooled transparent wall to separate the fuel-containing vortex region from the propellant region, while the open-cycle engine relies entirely on fluid mechanics containment for preferential retention of the nuclear fuel. The majority of the work has been directed toward the nuclear light bulb engine, since recent fluid mechanics results indicate that the fuel retention characteristics of an open-cycle vortex-stabilized engine are insufficient to provide economic fuel containment. The nuclear light bulb engine offers the possibility of providing essentially perfect containment of the nuclear fuel. The studies indicate approximate values of the thrust, weight, and specific impulse of both configurations. (auth) (STAR)

37516 (N-68-22257) EXPERIMENTAL INVESTIGATION OF REACTOR-LOOP TRANSIENTS DURING STARTUP OF A SIMULATED SNAP-8 SYSTEM. Thollot, Pierre A.; Block, Henry B.; Jefferies, Kent S. (National Aeronautics and Space Administra-

tion, Cleveland, Ohio. Lewis Research Center). May 1968. 46p. (NASA-TN-D-4546). CFSTI.

Experimental investigations of primary-loop transients during the startup of a Rankine-cycle space-power system were conducted in the SNAP-8 Simulator Facility at Lewis. Of particular significance to these studies was the fact that both a realistic reactor simulator and a flight-weight mercury boiler were used in the primary loop. Furthermore, the system tested used the same liquid metals and operated at similar temperatures, pressures, and flow rates as those of the SNAP-8 system. During startup, the electric heater power input was automatically controlled so that the transient behavior of a real reactor could be duplicated. With the exception of this automatic power control, all other variables were manually controlled to predefined values. In order to evaluate the relative merits of the wide variety of startup modes studied, a method of judging the results of each run was derived based on the reactor simulator exit temperature excursion. A comparison of this criterion with individual nuclear-system constraints showed excellent agreement. (auth) (STAR)

37517 (NAA-SR-12186) SNAP-2 DEVELOPMENTAL REACTOR MOCKUP NO. 1. Final Report. Maki, L.; Milner, J. F. (Atomics International, Canoga Park, Calif.). June 15, 1968. Contract AT(11-1)-Gen-8. 53p. Dep. CFSTI.

The acceptance level, shock, vibration, NaK loading, and thermal-vacuum operational tests demonstrated that the S2DRM-1 reactor assembly can survive the non-nuclear environments that would be imposed upon it from final assembly through start-up and 20 days of operation at temperature in a vacuum (simulating an earth orbit) without failure. The thermal-vacuum operational test was terminated (after 20 days) due to the failure of the NaK heater assembly, which was not part of the reactor system. Comparison of the performance record test data taken prior to and after each phase of testing showed no signs of degradation of the reactor assembly components. Following the failure of the NaK heater assembly during thermal-vacuum testing of the S2DRM-1 reactor system, a 30-element NaK heater and reservoir assembly was designed and fabricated for testing at elevated temperatures up to 1450°F. The heater and reservoir assemblies were not installed in the reactor system heat simulator due to program curtailment and thus the 90-day endurance objective was not fulfilled. Due to unavailability of SNAP 2 fine control drum motors, SNAP 10A flight-type motors (with mounting adapters) and controller were used to rotate the fine control drums during the tests conducted on the S2DRM-1 reactor assembly. The SNAP 10A fine control drum motors and controller demonstrated their compatibility with the SNAP 2 reflector assembly and operating requirements. The vacuum chamber pressure obtained using the titanium sublimation and ion pumping system (UHV) system during thermal-vacuum testing of the S2DRM-1 reactor system substantiated the pre-test information. A preliminary pumpdown of the modified vacuum chamber was conducted prior to installing the reactor system. An ultimate pressure of 5×10^{-10} torr was obtained in the clean, dry, and empty chamber without bakeout. The lack of area and time to prepare and test the UHV equipment resulted in problems with high-voltage leads and proper aiming of the electron-beam guns. Methods of correcting the problems encountered were devised. Due to program curtailment they have not been tested. Preliminary test results indicate that there was insufficient developmental testing of the UHV system prior to its use in testing the S2DRM-1 reactor system. (auth)

37518 (TRW-690-33) CORROSION PRODUCTS IN THE SNAP 2/MRPCP CRU V TEST SYSTEM. Topical Report No. 35. Schulze, R. C.; Vargo, E. J. (TRW Equipment Labs., Cleveland, Ohio). June 1968. Contract AT(04-3)-690. 144p. (TRW-ER-7253). Dep. CFSTI.

The results of a study of the Hg corrosion product problem in the MRP/SNAP 2 system are presented and discussed. It was established in this study that the primary source of corrosion products in the system Hg was the boiler. High quality Hg vapor must be maintained in order to prevent the introduction of an inordinate amount of corrosion products into the turboalternator (CRU V) by liquid carryover. Spectrographic analysis of hot Hg samples taken during operation was used to monitor the corrosion product level. Upon startup of a test the corrosion product level in the system Hg is relatively high. However, steady state operation soon produces a very low level of corrosion products in the liquid Hg. Careful control of system materials, vacuum integrity and cleanliness significantly reduce the corrosion product burden. The characteristics of the corrosion product deposition in the vapor regions of the system vary from those found in the liquid region. The deposits in the former were metallic (Cr, Ni, Fe, and Co) and those which deposited in the liquid section were present as spinels (Fe_2O_3 and Me_3O_4). Electron microscopy, electron diffraction and electron beam microprobe techniques were used to evaluate the corrosion and corrosion products. (auth)

37519 NUCLEAR REACTOR CORE FOR A ROCKET. Rom, Frank E.; Lietzke, Armin F.; Hyland, Robert E. (to National Aeronautics and Space Administration). U. S. Patent 3,374,148. Mar. 19, 1968. Filed Aug. 7, 1967.

A reactor core with a plurality of fuel elements in the form of plates of UO_2–WO_2 clad with W is described. The plates are stacked with beryllium oxide moderator in spaced relationship to provide passages for liquid rocket propellant. (auth)

37520 NUCLEAR ANALYSIS OF GAS CORE-REACTORS FOR SPACE PROPULSION SYSTEMS. Tumm, G. W. (Univ., Berlin). Atomkernenergie, 13: 271-84(1968). (In German).

The critical mass of the two main types of gas core-reactors — the "coaxial flow"-device and the "vortex flow"-device — is calculated. The applicability of these reactors on future space propulsion systems is specifically considered. The calculations are performed using the LASL-16 group cross sections revised in the thermal and the resonance region. The following effects are analyzed: geometry of the reactor, fuel density distribution, hydrogen within the reactor cavity, nozzle, pressure vessel and reactor operating temperature. (auth)

37521 NUCLEAR ROCKET ENGINE. Willinski, M. I.; Lamont, E. A. (to United States Atomic Energy Commission). U. S. Patent 3,383,858. May 21, 1968.

A nuclear rocket engine is described. The engine is comprised of a thrust chamber including a reactor core, a nozzle section, a heat exchanger, a rocket propellant fluid, a liquid coolant-reflector, a closed-loop conduit system to transfer the liquid coolant-reflector through the heat exchanger, and a conduit system to transfer the propellant through the heat exchanger to the reactor core where it is vaporized and subsequently ejected from the nozzle for rocket thrust. (AEC)

37522 NUCLEAR ROCKET ENGINE. Willinski, Martin I.; Lamont, Ernest A. (to North American Rockwell Corp.). U. S. Patent 3,383,858. May 21, 1968. Filed Aug. 9, 1956.

The description of a nuclear rocket engine is presented. The engine consists of a thrust chamber including a reactor core with an external coolant-reflector, a nozzle section having coolant passages located in its wall, a heat exchanger, a rocket propellant fluid of ammonia, a liquid coolant-reflector of water, a closed-loop conduit system adapted to transport the liquid coolant-reflector through the heat exchanger, a conduit system to transport the fluid propellant through the heat exchanger, and injection system for transporting fluid propellant into the core. A bleed-off system at the core exit provides a drive system for the turbine pump. (D.C.C.)

Process Heat and Desalination Reactors

37523 METHOD OF OPERATING A NEUTRONIC REACTOR FOR REFORMING GAS MIXTURES AND PRODUCING HEAT FOR MULTI-PURPOSES. Miller, E. F. (to United States Atomic Energy Commission). U. S. Patent 3,394,050. July 23, 1968.

A method of operating a nuclear reactor to simultaneously produce chemicals and generate heat for electric power production and desalination is described. The reactor is provided with a plurality of coolant channels extending through its active core region and is cooled by endothermically reacting a mixture of steam and hydrocarbon. The reformed coolant gas is converted to carbon dioxide and hydrogen before passing through a heat-exchange boiler where steam is generated. The generated steam is used as a source for the gas reforming reaction within the reactor, for power generation, and for other purposes including water desalination using known distillation techniques. (AEC)

37524 IMPROVEMENTS IN OR RELATING TO DESALTING PLANT COMPRISING A NUCLEAR REACTOR. Hitchcock, Anthony John Michael (to United Kingdom Atomic Energy Authority). British Patent 1,113,232. May 8, 1968. Filed June 25, 1964.

The description of a dual-purpose power and desalination gas-cooled nuclear reactor is presented. The gas coolant is fed directly from the core to the gas turbines for power production. The turbine effluent is used in a brine heater. The gas coolant also drives a compressor for core coolant. The heat recovered from the compressor is used for a second brine heater. (D.C.C.)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 36111 and 37312.

37525 (AERE-R-3912) AN EXPERIMENT TO MEASURE DIFFUSION COEFFICIENTS DESCRIBING THE RATE OF ESCAPE OF FISSION PRODUCTS FROM URANIUM-GRAPHITE FUEL. PART 2. Brown, P. E.; Flowers, R. H.; Lupton, D. F. M. (Atomic Energy Research Establishment, Harwell (England)). June 1962. 28p. Dep. CFSTI. UK.

Results obtained from a post-irradiation examination of an in-pile loop designed to study fission product diffusion from DRAGON fuel samples are presented. The operational history of the loop is given, together with a description of some faults which developed. (auth)

37526 (ANL-7448) PRELIMINARY SAFETY ANALYSIS REPORT ON THE ARGONNE ADVANCED RESEARCH REACTOR. Fromm, L. W.; Matousek, J. F.; Rohde, R. R.; Shaftman, D. H.; Tessier, J. H. (Argonne National Lab., Ill.). June 1968. Contract W-31-109-eng-38. 638p. Dep. CFSTI.

Information on the Argonne Advanced Research Reactor (A^2R^2) is given under the following broad topics: Introduction; Principal Safety and Design Criteria including comparison of the A^2R^2 design with the AEC General Design Criteria; Site Characteristics; Description of Design; Reactor Facility Operation; and Safety Analysis and Evaluation including accidents involving reactivity transients, fuel handling accidents, equipment malfunction and primary coolant system rupture, radioactivity release unrelated to primary system rupture, fire and environmental accidents, and missile generation; Maximum Credible Accident Analysis; and Analyses of Hypothetical Accidents. Appendices include reactor physics characteristics, survey of metal-water reaction data relevant to A^2R^2, dynamic behavior of core, aspects of A^2R^2 research and development program important to safety, reactor vessel containment potential, and containment overpressure calculation method. (M.L.S.)

37527 (ANL-Trans-609) STUDY OF THE OPERATION OF AN ASSEMBLY OF FUEL ELEMENTS CONTAINING PLUTONIUM DIOXIDE FUEL IN THE BR-5 REACTOR. Kazachkovskii, O. D.; Votinov, S. N.; Lebedev, I. G.; (and others). Translated by C. E. Stevenson (Argonne National Lab., Ill.), from At. Energ. (USSR), 24: 136-43(Feb. 1968). 12p. Dep. CFSTI.

Dimensional changes, fission gas production, metallurgical structure changes, and mechanical property changes were studied for a stainless steel-clad PuO_2 fuel element assembly irradiated to 6.1% burnup in the BR-5. (H.D.R.)

37528 (BAW-3647-8) PHYSICS VERIFICATION PROGRAM. PART III. Quarterly Technical Report, January-March 1968. Baldwin, M. N.; Stern, M. E. (Babcock and Wilcox Co., Lynchburg, Va. Critical Experiment Lab.). June 1968. Contracts AT(30-1)-3647; 41-2007(RDE 2559). 14p. Dep. CFSTI.

A description of a high-temperature test vessel and related equipment located adjacent to the LPR core is presented. The test vessel and equipment are used to study the signal current from a rhodium-type incore power monitor in relation to the neutron flux at operating power reactor temperatures. Signal current versus neutron flux will be determined at a variety of temperatures and boron moderator concentrations. (D.C.C.)

37529 (BNWL-752) HEALTH PHYSICS CONSIDERATIONS DURING PRTR RECOVERY AND DECONTAMINATION. McConnon, D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 17p. Dep. CFSTI.

On September 29, 1965, the Plutonium Recycle Test Reactor (PRTR) experienced a fuel element and pressure tube failure during which approximately 700 g of fuel material was released from the fuel element. The health physics approach to the recovery and decontamination phase, and the radiological conditions experienced during this phase and during the subsequent startup of the reactor are presented. No significant quantities of airborne or surface plutonium contamination were detected during either the recovery and decontamination phase of subsequent reactor operation. The approach to recovery and decontamination was the same as that which would be used at a uranium-fueled reactor. (auth)

37530 (BNWL-SA-1630) CRITICAL EXPERIMENTS WITH HOMOGENEOUS PuO_2-POLYSTYRENE AT 5 H:Pu. Bierman, S. R.; Hansen, L. E.; Lloyd, R. C.; Clayton, E. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 21, 1968. Contract AT(45-1)-1830. 13p. (CONF-680601-18). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Criticality parameters for mixtures of fuel having an 11.5 wt % ^{240}Pu isotopic concentration and an atomic H/Pu ratio of 5 are presented. Experimental data are obtained from both bare and reflected rectangular parallelepipeds of PuO_2-polystyrene fuel. (D.C.C.)

37531 (DUN-SA-70) CALCULATIONS OF PHYSICS PARAMETERS FOR MIXED FUEL-TARGET LATTICES. Agee, L. J. (Douglas United Nuclear, Inc., Richland, Wash.). May 22, 1968. Contract AT(45-1)-1857. 26p. (CONF-680601-17). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Methods and combinations of computer programs for predicting known lattice physics parameters are described. All the different methods of analysis are correlated with the results of four representative tests performed in the Physical Constants Testing Reactor. (D.C.C.)

37532 (IDO-17242) ENGINEERING AND TEST BRANCH QUARTERLY TECHNICAL REPORT, OCTOBER 1-DECEMBER 31, 1967. Dietz, K. A. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). May 1968. Contract AT(10-1)-205. 75p. Dep. CFSTI.

REACTOR SAFETY EXPERIMENTS—fuel element radiation levels following LOFT critical experiment, (T); emergency core coolant injection in LOFT, boron poison concentration in, (T); fuel cladding failure analysis in LOFT, TCP code for; γ heating in LOFT core during operation, QAD-B code analysis of; radiation dose rates in containment building following LOFT emergency core cooling system test, (T); core loading analysis in LOFT blowdown tests, comparison of techniques for; fission gas release to fuel rod plenum during LOFT tests, (T); emergency core coolant injection in simulated LOFT tests, heat transfer mechanisms during, (E); blowdown process testing in quarter-scale LOFT vessel, hydrodynamics and mechanical response measurements during; fission product release sampling in LOFT, effectiveness of removable plateout capsules for, (E)

REACTOR FUEL ELEMENTS—γ activity of LOFT, following critical experiment, (T); cladding failure analysis in LOFT, TCP code for

DECONTAMINATION—effects on radiation levels in LOFT containment vessel lined with stainless steel, (T)

REACTOR CONTAINMENT STRUCTURES—decontamination effectiveness on painted and stainless steel-lined surfaces of LOFT, (T)

FISSION PRODUCTS—release to fuel rod plenum during LOFT tests, (T); sampling in LOFT tests, effectiveness of removable plateout capsules for, (E); containers for samples from LOFT tests, evaluation of efficiency of, (E)

HEAT TRANSFER—analysis in simulated reactor core heatup and emergency coolant injection tests, (E(

REACTORS, WATER-COOLED; BROWNS FERRY POWER REACTOR, UNIT 1—coolant loss accidents in, thermal transient behavior following, (T)

REACTOR SAFETY—coolant loss accidents in large water-cooled reactors, thermal transient behavior following, (T) (H.D.R.)

37533 (LFEN-NI,-34a) ENVENENAMENTO DO RPI PELOS PRODUTOS DE CISAO ^{135}Xe E ^{149}Sm. (Poisoning of RPI from the Fission Products ^{135}Xe and ^{149}Sm). Martinho, E. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1968. 30p. (In Portuguese). Dep.

The mechanisms of ^{135}Xe and ^{149}Sm buildup in a reactor and its effects on reactivity are described. The kinetics equations are developed to account for precursor density; multigroup formulations are given. Results of measurements in the RPI research reactor are compared with calculated values. (M.L.S.)

37534 (N-68-11068) COMPARISON OF MEASURED AND MONTE CARLO CALCULATED GAMMA DOSE IN THE TUNGSTEN WATER-MODERATED CRITICAL ASSEMBLY. Klann, Paul; Paulson, Walter (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1967. 16p. (NASA-TM-X-52358; CONF-671102-40). CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

A Monte Carlo digital program, ATHENA, was developed and used to calculate the rate of gamma heat deposition in the Tungsten Water-Moderated Nuclear Rocket as a function of position. The results were compared and evaluated against measurements of the gamma dose throughout the core of the Tungsten Water-

Moderated Reactor (TWMR) mockup critical assembly. Data curves are given. The TWMR critical assembly is briefly described; and schematic cross sectional diagrams of the assembly, fuel element, and graphite ionization chamber are depicted. (STAR)

37535 (N-68-15643) EXPERIMENTAL DETERMINATION OF NEUTRON FLUXES IN PLUM BROOK REACTOR HB-6 FACILITY WITH USE OF SULFUR PELLETS AND GOLD FOIL. Bozek, John M.; Godlewski, Michael P. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 23p. (NASA-TM-X-1497). CFSTI.

Fast and thermal neutron fluxes were measured in the test cavity outside the HB-6 beam port in the Plum Brook reactor, with the use of S pellets and Au foils. The dependence of flux on reactor power level, shim-control-rod position, water attenuator tank configuration, position in the test cavity, and perturbations by other experiments was investigated. Based on the measurements taken, the thermal and fast neutron fluxes for any combination of these parameters can be determined. Standard fluxes (which correspond approximately to an average flux in the test cavity at full reactor power) were 1.4×10^6 neutrons per sec per sq cm (nv) for thermal neutrons ($E \leq 0.4$ eV or 0.64×10^{-7} pJ) and 8.2×10^6 neutrons per sec per sq cm (nv) for fast neutrons ($E \geq 2.48$ MeV or 0.396 pJ). The flux errors are estimated at ±38 and ±35% for thermal and fast neutrons. (auth) (STAR)

37536 (N-68-15855) NUCLEAR DESIGN DATA FOR EXPERIMENTS TO BE CONDUCTED IN HORIZONTAL THROUGH HOLE 1 OF THE PLUM BROOK REACTOR. Rohal, Robert G.; Finnegan, Patrick M.; Ciesla, E. J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 31p. (NASA-TM-X-1509). CFSTI.

Three irradiation facilities have been designed for use in the Horizontal Through Hole 1 (HT-1) of the Plum Brook Reactor (PBR). These facilities are the Inpile Helium-Cooled Loop, the Single-Pass Argon-Cooled Facility, and the Inpile Capsule Facility. Experiments were conducted in HT-1 of the Plum Brook Mockup Reactor (MUR) to provide data for experiments employing these facilities. In these experiments, mockups of the three facilities were used to obtain the following information: (1) the thermal-neutron flux, which ranged from approximately 1×10^9 to 4×10^9 neutrons per square centimeter per second per kw of reactor power along the axis of the inpile tubes; (2) the fission power in mockups of flat-plate fuel elements composed of W and approximately 10 to 25 grams of fully enriched U which ranged from approximately 0.04 to 0.10 watt per gram of enriched U per kw of reactor power; (3) the γ heating in the inpile tube structure, which ranged from approximately 0.5×10^{-4} to 1.0×10^{-4} W per g per kw of reactor power; (4) the reactivity worth of the mock fuel elements and inpile tubes in both normal and accident conditions, which ranged from −4 to −40¢, respectively. (auth) (STAR)

37537 (N-68-16056) CALCULATIONS TO SUPPORT OPERATION OF THE PLUM BROOK REACTOR. Reilly, Harry J.; Lynch, John H.; Borbash, Steven R. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 25p. (NASA-TM-X-1496). CFSTI.

Several calculations that have aided operation of the Plum Brook Reactor are described. First, a simple mathematical model and the resulting calculations which were done to study fuel utilization are described. A decision to buy 240-gram ^{235}U fuel elements and to use them three times each was made on the basis of the study. The power distribution in the mixed loading is discussed and is observed to be more uniform than that in a uniform fuel loading. Charge life weight factors are then derived; the derivation differs in approach and in results from previous derivations by others. Finally, a "xenon clock" on-line computer program in use at the reactor is discussed, and an approximation useful for hand calculations of complex histories is derived. (auth) (STAR)

37538 (N-68-17022) EXPERIMENTAL DETERMINATION OF GAMMA EXPOSURE RATE IN PLUM BROOK HB-6 FACILITY. Bozek, John M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 14p. (NASA-TM-X-1490). CFSTI.

The γ ray exposure rates in the HB-6 beam hole facility of the NASA Plum Brook Reactor were measured with LiF thermoluminescent dosimeters and Ar-filled ion chambers. The exposure rates varied as a function of position in the test cavity and the time of measurement. To define and predict variations of the γ exposure rate, an empirical relation between a standardized exposure rate and various reactor parameters was formulated. The standardized exposure rate, defined at 60 MW of reactor power, median values of reactor parameters, and the center of the radiation beam, were measured to be 7.6×10^4 roentgens per hour (19.6 (C/kg)/hr). (auth) (STAR)

37539 (N-68-22022) GAMMA FLUX AND HEAT DEPOSITION IN PLUM BROOK REACTOR: COMPARISON OF CALCULATION AND EXPERIMENT. Bacigalupi, Robert J.; Thinger, Byron E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1968. 24p. (NASA-TM-X-1539). CFSTI.

A computerized point-kernel technique (QAD-P5) was used to calculate a gamma-heating map of a thermionic diode experiment proposed to be irradiated in the Plum Brook reactor core. A replica of the diode was used in the low-power mockup reactor at Plum Brook to generate corresponding gamma-heating maps experimentally using lithium fluoride dosimetry. A detailed comparison of experimental and calculated values generally showed agreement to within ±25 percent. Proper interpretation of the measured values is discussed herein. (auth) (STAR)

37540 (ORNL-3572(Rev.2)(Vol.1B)) THE HIGH-FLUX ISOTOPE REACTOR: A FUNCTIONAL DESCRIPTION. VOLUME 1B. ILLUSTRATIONS. Binford, F. T.; Cramer, E. N. (eds.) (Oak Ridge National Lab., Tenn.). June 1968. Contract W-7405-eng-26. 174p. Dep. CFSTI.

Diagrams and drawings of the HFIR site, buildings, reactor, auxiliary facilities, and reactor components, systems, and instruments are presented. (H.D.R.)

37541 (ORNL-TM-2197) FABRICATION OF RESEARCH REACTOR FUEL ELEMENTS. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.). June 1968. Contract W-7405-eng-26. 25p. (CONF-680114-1). Dep. CFSTI.

From AEC Industry Meeting, Water Reactor Fuel Element Technology, Washington, D. C.

A discussion is presented on the fabrication techniques used to fabricate fuel elements for research reactors. Such fuel elements are aluminum base with fuels of either uranium−aluminum alloy or dispersions of powered U_3O_8 or UAl_3 in aluminum powder. Emphasis is on the latter types which are the ones used in the advanced high performance reactors such as HFIR and ATR. The primary operation or design problem affecting fabrication is control of hot spots. This requires close control of uranium loading and distribution, core thickness, quality of bonds, absence of blisters, and uniform water-channel thickness. Control of each factor is discussed. The fabrication of the dispersion plates is divided into the following areas: powder preparation, core fabrication, plate rolling, and inspection. Techniques for both U_3O_8 and UAl_3 are presented. Assembly operations are included for elements joined both by the mechanical roll swaging technique and by welding. The latter represents the technique now being used to fabricate the HFIR elements. (auth)

37542 (RT/FI-(68)-13) MISURE DI DISTRIBUZIONE DI POTENZA SPECIFICA IN ALCUNI MOCK-UPS IRRAGGIATI NEL REATTORE RITMO. (Measure of the Specific Power Distribution in Several Irradiated Mock-Ups in the RITMO Reactor). Bozzi, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 33p. (In Italian). Dep.

Irradiations of two series of mock-ups containing respectively 25%-enriched UO_2 rods and $UO_2-B_2O_3$ natural rods with the same absorption cross section have been realized in the RITMO reactor at CNEN, Casaccia. The methods for measuring the specific power generated in the 25%-enriched UO_2 monitors inserted in the rods using different nondestructive techniques of post-irradiation analysis are discussed. (auth)

37543 MATERIAL BUCKLING MEASUREMENTS IN THE ANNA CRITICAL ASSEMBLY. Bouzyk, J.; Kubowski, J.; Latek, S. (Inst. of Nuclear Research, Swierk, Poland). At. Energ. (USSR), 24: 425-9(May 1968). (In Russian).

The differential reactivity method has been applied to determine the material buckling as well as the reflector savings in the reflected, heterogeneous, water-graphite moderated system with enriched uranium. The measuring technique and the results obtained are described. The results are discussed with respect to the application of the water height experiment to a complex reactor system. (auth)

37544 RADIATION STABILITY OF SM-2 REACTOR PLATE FUEL ELEMENTS. Chushkin, Yu. V.; Davydov, E. F.; Syuzev, V. N.; Guseva, T. M.; Kolesov, V. V.; Deribizov, M. D. At. Energ. (USSR), 24: 432-5(May 1968). (In Russian).

The data obtained by investigation of the reactor SM-2 laminar fuel elements made as straight plates 280×33, 4×0.8 mm by size are summarized. Electrolytic nickel was used as cladding and matrix material. The fuel is UO_2 (enrichment up to 90%) 40 per cent by volume. The fuel elements investigated were operated at a maximum thermal flux of 6×10^6 kcal/m^{2}h, a cooling water

temperature of 80°C, a maximum cladding temperature of 200°C, and a maximum temperature within the center of 280°C. The fuel elements were investigated until a burn-up of 1.9–30%. The dispersive laminar fuel elements with the burn-up of 30% showed very high stability, except some fuel elements that lost to some extent the tightness because of scaling probably developed during the cooling process. Structure disturbances caused by the annealing at 300°C are very small. It is shown that the change in the fuel element volume was caused by solid state swelling which is in linear dependence on burn-up. The lower temperature limit of the gas swelling is about 350°C. Good structure stability of all fuel element components and the absence of visible changes of the form, continuity, grain structure and configuration of the fuel constituent were noted. Fuel elements described showed sufficient reliability. (auth)

37545 THE REACTIVITY METER CMR-66. DESCRIPTION AND UTILIZATION IN TEST AND POWER REACTORS. Brosson, M.; Cavee, G.; Chauvet, G.; Meunier, C.; Tornier, E. Ind. At., 12: No. 1-2, 37-42(1968). (In French).

A complete description of an on-line device for measuring reactivity is given. The basic operational principles are outlined. Measurements made in the Siloette reactor are tabulated. Positioning effects, chamber compensation for γ effects, and proper chamber current are discussed. The results obtained are compared with other reactivity measuring methods; reproducibility of results is considered. (M.L.S.)

37546 THE JEN-2 REACTOR: DESCRIPTION. Montes Ponce de Leon, J.; Martin Nuno, C.; Fajardo Cantillo, M. Energ. Nucl. (Madrid), 12: 4-12(Jan.-Feb. 1968). (In Spanish).

Complete qualitative and quantitative descriptions of the JEN-2 Spanish research reactor are given. Cut-aways show the pool of the JEN-2 and its relative location to JEN-1; a longitudinal cross section of the control rod and control rod drive is shown. Design parameters are tabulated; safety features are listed. Schematics and block diagrams of the alarm and emergency circuits are shown; these systems are described. (M.L.S.)

37547 ROD FOR GRABBING AND HANDLING A RADIOACTIVE MATERIAL IN A NUCLEAR REACTOR. Okada, Shige (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-19559. Oct. 2, 1967. Filed July 15, 1964.

The grabbing and handling rod proposed is designed for swimming-pool type reactor. The device consists of a handling rod; a gripping device installed at the bottom end of this rod for grabbing and releasing a radioactive material; a means installed along the rod for transmitting the power of grabbing or releasing to the gripping device at the bottom end; and a plurality of lever mechanisms to operate the power transmitting and gripping device installed along the rod at intervals. (NSA of Japan)

37548 IRRADIATION DEVICE. Matsuda, Naoe (to Hitachi Ltd.). Japanese Patent 1967-17915. Oct. 17, 1967. Filed Apr. 16, 1964.

A unique irradiation device, associated with a nuclear reactor, is proposed. By this device, the position of a sample material, with respect to the reactor core, can be easily adjusted in the irradiation experiment. The reactor core is submerged in pool water. A spiral of pipe is installed vertically in the pool surrounding the reactor core at the bottom; a sample can pass through the pipe. The sample can take any position in the pool, by manipulation of a rope attached to it. (NSA of Japan)

37549 IN-PILE LOOP. Aoki, Naoji (to Hitachi Ltd.). Japanese Patent 1967-17913. Oct. 17, 1967. Filed May 22, 1963.

In the in-pile loop proposed, the temperature in the sample placed in the reactor is adjusted by the flowing coolant. A coolant-circulating circuit is formed, including the sample irradiation facility, for forced circulation. Outside the reactor heater is installed to heat the coolant. A cooling jacket can be evacuated or filled with a flowing gas in order to adjust the heat radiation. (NSA of Japan)

37550 STUDY OF THE CONTROL OF IRRADIATION LOOPS OF THE PEGASE REACTOR WITH PHASE METHODS. Guintrand, Claude; Sideriades, Lefteri (CEN, Cadarache, France). Compt. Rend., Ser. A and B, 266: 774-6(Apr. 8, 1968). (In French).

Phase methods were applied in a three-dimensional space in order to study the control of the temperature of the cooling gas which circulates in an irradiation loop. The dynamic system has a boundary and a unique singular point. The stability and the damping were discussed using two parameters k and k′ of the control circuit. (tr-auth)

37551 MEASUREMENTS OF FAST FISSION RATIO IN NATURAL URANIUM CARBIDE HEAVY WATER LATTICES. Maracci, G.; Rustichelli, F. (CCR–EURATOM, Ispra, Italy). Energ. Nucl. (Milan), 15: 330-4(May 1968).

The measurements of the fast fission ratio performed at the ECO reactor in natural uranium carbide heavy water lattices, by the integral gamma counting technique, are presented. The results of the measurements carried out on three different types of elements are compared with theoretical values calculated by the PINOCCHIO code; the agreement found is satisfactory in all the cases investigated. (auth)

Production Reactors

Refer also to abstract 36430.

37552 (CONF-680802–1) ELECTRICAL COMPONENT TECHNOLOGY FOR 1/4 TO 10 MEGAWATT SPACE POWER. King, A. E.; Fanger, J. B. (Westinghouse Electric Corp., Lima, Ohio); Leighton, G. S. (Atomic Energy Commission, Washington, D. C.). Aug. 1968. Contract AT(04-3)-679. 13p. Dep. CFSTI.

From 3rd Annual Intersociety Energy Conversion Engineering Conference, Boulder, Colo.

Analytical data are presented for electrical power system components in advanced high-temperature, potassium Rankine nuclear space power systems. Power level and coolant temperature were used as independent variables to define combined minimum weight, maximum efficiency configurations based on an extensive background in the development of high temperature electrical materials, ac generators and motors, and power conditioning equipment for space applications. The data presented forecast electrical power system component design limitations and envelopes of minimum weight designs relative to such major systems parameters as temperature, shaft speed, voltage and frequency. Representative missions were analyzed for purposes of defining the ranges and types of electrical power needs and corresponding components. (auth)

37553 (DUN-SA-69) THE APPLICATION OF THE HAMMER COMPUTER CODE TO EX-REACTOR CRITICALITY CALCULATIONS. Chitwood, R. A. (Douglas United Nuclear, Inc., Richland, Wash.). May 3, 1968. Contract AT(45-1)-1857. 23p. (CONF-680601-19). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Comparisons between calculated results using the HAMMER computer code and experimental data for a number of water-moderated, low enrichment systems are presented. Designs represent typical fuel geometries for the New Production Reactor. Calculations presented include: material buckling in water of discharged NPR fuel as a function of exposure; and criticality safety of a fuel shipping cask. (D.C.C.)

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 36025, 36038, 36121, 36123, 36127, 36128, 36448, 36508, 36509, 36524, 36532, 36533, 36550, 36552, 37211, 37273, and 37275.

37554 (APDA-209) TWO-DIMENSIONAL HYPOTHETICAL ACCIDENT INVESTIGATION OF A MIXED-OXIDE CORE DESIGN FOR THE FAST TEST REACTOR. Ball, G. L.; Klickman, A. E.; Wehmeyer, D. B.; Yeh, C. S. (Atomic Power Development Associates, Inc., Detroit, Mich.). June 1968. Contract AT(11-1)-865. 31p. Dep. CFSTI.

A two-dimensional study of the effects of core geometry, fuel enrichment zoning, and a central core inhomogeneity upon the value of the energy release during the maximum hypothetical accident for the reference design Fast Test Reactor (FTR) core is presented. The MARS code was used for the two-dimensional energy release calculations. (auth)

37555 (EUR-3921) THE PROCELLA METHOD FOR HEAVY WATER LATTICES. Bonalumi, R.; Palazzi, F.; Pierini, G. (Centro Informazioni Studi Esperienze, Milan (Italy)). 1968. 285p. Dep.

The method described regards in principle D_2O lattices. It is based on simplified models, so as to require no adjusted constants, while calculations are accurate and very rapid. The method follows a 4-group breakdown of neutron spectrum (fast, resonance, epithermal and thermal) to yield corresponding lattice diffusion parameters. Fissioning and absorption occur in all groups. Extensive use is made of properly developed first-collision probability methods. Main original features are: (1) an original definition of the resonance absorption effective surface; (2) an analytical calculation of the ^{238}U resonance escape probability

allowing for high energy flux peaking and using a simplified absorption cross section which reproduces Hellstrand's resonance integrals; (3) a very special, analytical treatment of thermalization in the fuel element, starting from a Westcott-like flux in the moderator; (4) epithermal cross sections including disadvantage and shielding factors, the latter ones being obtained by a generalized equivalence theorem for resonance capture. Standard "transport" methods are used in calculating thermal fine flux (Amouyal-Benoist) and cell diffusion coefficients (Benoist). The method was tested on a number of experiments: (1) the K_{eff} of about 300 experimental critical assemblies was calculated, showing that the calculated K_{eff} is generally less than 1 by less than 0.005, 89% of data being within ±0.01 from the average K_{eff}; (2) some detailed lattice parameters were also compared with their experimental values, obtaining an acceptable agreement. A systematic underestimate in p, increasing with the fuel element size, is due to neglecting spatial interference effects. The method is embodied in the PROCELLA code, written for the IBM 7040 digital computer. Each problem takes no more than 10 sec, thus making this method very attractive for long-term reactivity studies. The code was also carefully conceived so as to give most of the output data useful in design studies (differential coefficients) and in comparisons with experiments. (auth)

37556 (EUR-3930) ECLIPSE: DIGITAL NEUTRON TRANSPORT PROGRAMME FOR TREATING THE NON-UNIFORM BURN-UP OF BURNABLE POISON PARTICLES INCORPORATED IN REACTOR FUEL. Raaijmakers, W. A. (Reactor Centrum Nederland, The Hague). Mar. 20, 1968. 86p. Dep.

An outline of the physics and mathematics of a computer programme that calculates two-group neutron fluxes and associated burn-up of poison atoms within a spherical burnable poison particle is presented. The problem consists in evaluating the neutron fluxes in three spherically concentric regions, the poison sphere being located at the center of the system whereas the two surrounding regions may be, respectively, fuel and moderator or a carrier material and/or moderator. Subsequently, a time-step is taken during which some of the poison and fuel atoms will be consumed and, eventually, formed whilst also the total neutron absorption rate by the particle is computed. During the time-step the neutron fluxes are assumed not to change. With the new concentrations of poison and fuel atoms the neutron fluxes for the following time-step are determined. This process is continued for a specific number of time-steps giving as a result the total neutron absorption rate by the particle as a function of time or as a function of the integrated flux-time (i.e., irradiation) in the neighboring region containing fuel or the carrier material. This result is of great value in core or cell burn-up studies where the application of burnable poisons in lumped form is being considered. The choice of carrier material like Al makes the analysis of irradiation and/or oscillator experiments possible. An option is available for linear anisotropy of the neutron flux incident at the poison's surface. (auth)

37557 (EUR-3931) COMPARATIVE STUDY ON THE NON-UNIFORM BURN-UP OF BURNABLE POISON PARTICLES USING ANALOGUE AND DIGITAL COMPUTER TECHNIQUES AND A NEW DEFINITION OF THE SELF-SHIELDING FACTOR. Raaijmakers, W. A. (Reactor Centrum Nederland, The Hague). Apr. 20, 1968. 42p. Dep.

A comparative study has been undertaken on the behavior of lumped absorbers (burnable poison particles) under neutron irradiation pursuing two different ways. One uses a rather simple analog model, the other a more sophisticated digital computer programme. Upon comparison of the results it is possible to conclude that also the first method adequately predicts the absorption characteristics provided the adjustment of the analog model to some recent developments pertaining to the definition of the self-shielding factor. (auth)

37558 (IA-1156) ERROR ESTIMATION FOR CRITICALITY AND REACTIVITY COEFFICIENTS CALCULATIONS IN FAST REACTORS. Gitter, L.; Yiftah, S. (Israel Atomic Energy Commission, Tel Aviv). Feb. 1968. 27p. Dep.

A "second order perturbation" method for the computation of reactivity is suggested as well as a method for the computation of a number of parameters for the estimation of the errors involved. Several computations of Doppler and Na-void effects are performed in order to test the efficiency of the methods. The results are given in tabular form. (auth)

37559 (ITEF-563) NEKOTORYE ZADACHI GETEROGENNOI TEORII REAKTORA. (Some Problems in Regard to the Heterogeneous Theory for a Reactor). Galanin, A. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 39p. (In Russian). Dep.

General heterogeneous equations for a reactor with the reflector of the same properties as the moderator in the reactor are formulated in two-group approximations. It is supposed that the distance between fuel elements is much larger than the scattering length in the moderator. In the diffusion approximation, the kind of boundary conditions at the surface of each fuel element is established. The following questions are considered: the length of migration in the direction of the axes of fuel elements; critical conditions and mutual block-effect for the double lattice; reactor inhomogeneous in height; and length of migration in the direction normal to the axis of fuel elements. (auth)

37560 (K-DP-3105) A COMPARISON AT TWO METHODS OF INNER ITERATION CONVERGENCE ACCELERATION IN DISCRETE ORDINATES CODES. Engle, W. W. Jr.; Mynatt, F. R. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). [nd]. Contract W-7405-eng-26. 11p. (CONF-680601-20). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

A comparison of methods used for accelerating convergence of the inner integrals occurring in the discrete ordinates method of numerical analysis is given. The convergence methods described are the standard scaling, space dependent scaling, and Chebyshev methods. An example of an adjoint flux calculation in air is given. (M.L.S.)

37561 (N-68-22587) DESIGN, FABRICATION, AND FABRICATION EVALUATION OF HIGH-TEMPERATURE FUEL PINS. Final Report. Gulley, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 22, 1968. Contract NAS3-7960. 37p. (NASA-CR-72387). CFSTI.

A total of twenty-seven Mo clad fuel pins were designed and fabricated. The purpose of the pins is to provide irradiation data needed for the design of full-length reactor fuel pins. Six of the fuel pins contained depleted uranium dioxide (UO_2); fourteen contained fully enriched UO_2; one contained depleted uranium nitride (UN); and six contained fully enriched UN. (auth) (STAR)

37562 (RT/FI-(68)15) ASYMPTOTIC POLE CONTRIBUTIONS IN NEUTRON TRANSPORT THEORY. Boffi, V. C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 18p. (CONF-660624-4). Dep.

From EAES Symposium on Advances in Reactor Theory, Karlsruhe, Ger.

Spatially dependent problems in neutron transport theory can be solved by using integral transform methods. The problem related to the space-time distribution of monoenergetic neutrons in the case of infinite medium of spherically symmetric scattering and isotropic infinite plane pulsed source is presented. (auth)

37563 CALCULATION OF A PARTICULAR SUPPORT STRUCTURE OF A NUCLEAR REACTOR. Curioni, Sergio (CNEN, Bologna); Freddi, Alessandro. Ing. Nucl., 8: No. 6, 29-40(Nov.-Dec. 1967). (In Italian).

The Rayleigh-Ritz energy method was used to study a particular support structure of the fuel elements of a reactor. The support studied consisted of a slab connected to some degree to the vessel and of a second slab hung from the first by means of tubes. The stress under various conditions of connection, slab weights, and numbers of tubes were determined. (tr-auth)

37564 CRITERION FOR COMPARING STATES OF REACTOR CORE FUEL ELEMENTS. Badanina, N. G.; Saikov, Yu. P. At. Energ. (USSR), 24: 429-32(May 1968). (In Russian).

The value of the equivalent content of U is suggested for comparing the state of fuel elements in the core. A method of determining the equivalent content of U as a sum of I, Sr, and Ba isotopes is described. (auth)

37565 KUGEL, A PROGRAM FOR CALCULATING THE SPACE DEPENDENT EQUILIBRIUM ISOTOPE MIXTURE IN A PEBBLE BED REACTOR. Massimo, L. (Brown-Boveri/Krupp, Reaktorbau GmbH, Mannheim, Ger.). Nukleonik, 11: 72-6(May 1968). (In German).

The program calculates the statistical space distribution of the fuel elements in a pebble bed reactor considering the radial dependence of the axial velocity of the balls. It follows a ball during all its passages through the reactor until it is discharged, and calculates the probability to find it in each point of the core during each of its different burn-up stages. The composition of a fuel element is supposed to be fully defined by its irradiation. (auth)

37566 EXPERIMENTAL STUDY OF MANUFACTURE OF PLANAR FUEL ELEMENTS CONTAINING CERMET NUCLEI. Capocchi, Jose Deodoro Trani; Cintra, Sebastiao Hermano Leite; Gentile, Erberto Francisco (Instituto de Energia Atomica, Sao

Paulo, Brazil). Met. ABM (Ass. Brasil. Metais), 24: 201-12 (1968). (In Portuguese).

The obtained results in the manufacture of plates containing ceramic fuels (U_3O_8, 55, 60, 70, and 75%) are presented. Results give a perfect rolling of bodies with low plasticity, higher enrichment of uranium, smaller thickness, and plating. Aspects of cermet and plate production are described. The metallurgical characteristics of various plates produced during four years are compared. 16 references. (auth)

37567 PLUG FOR AN IN-PILE LOOP EXPERIMENTAL FACILITY. Amano, Makio (to Ishikawajima-Harima Heavy Industries Co., Ltd.). Japanese Patent 1967-17914. Oct. 17, 1967. Filed June 17, 1963.

The plug proposed has the following advantages: more room for instruments, improved shielding, and reduced cost. A sump is located just below the plug-shield, and above it is located a pump. A primary-coolant piping runs from the sump, through the plug shield, to the pump, back through the shield, and to the sump. The upper part of this piping, including both parts to and from the pump, consists of two concentric pipes. Through the outer space is run a secondary coolant exchanging heat; the latter coolant is led outside the reactor. The piping through the plug-shield runs spirally. (NSA of Japan)

37568 DEVICE FOR TRANSPORTING SAMPLES. Tani, Akira (to Nippon Atomic Industries Group Co., Ltd.). Japanese Patent 1967-17917. Oct. 17, 1967. Filed Mar. 30, 1964.

A convenient device is proposed for separating two samples irradiated in a nuclear reactor. The device is used for a sample under study and its monitoring-sample after in-pile irradiation in association with the pneumatic tube. The pneumatic-tube system includes: a tube extending to the reactor core; a second tube connected to the first tube at its middle and vertically; stoppers closing both ends of the upright tube; a third pipe connecting to the vertical pipe at right angles below the joint; and a device above the joint in the vertical tube to hold one sample. The other sample, in operation of the system, is then separated and falls down the upright tube onto the stopper. (NSA of Japan)

37569 DEVICE FOR TESTING THE SCRAM CHARACTERISTICS OF A REACTOR SAFETY ROD. Fukazawa, Hideo (to Fuji Electric Mfg. Co., Ltd.). Japanese Patent 1967-17905. Oct. 17, 1967. Filed Nov. 18, 1965.

The method proposed has the following advantages: compactness and simplicity, embodied construction, and ease of installation and removal. The device consists of the support plate for a reactor safety-control mechanism with one end attached to the mechanism support plate and the other to the reactor core; two supporting plates fixed at either end of the device support; a fixed contact-element located intermediately between the two plates; a resistance wire extended between the two plates; an element attached to the control-rod driving rod; oscillograph circuits connected to both ends of both the two elements with dc power sources; and, an oscillograph circuit which connects a lead wire with a dc power source. (NSA of Japan)

37570 NUCLEAR FUEL ELEMENTS. Aizu, Tadashi (to Hitachi Ltd.). Japanese Patent 1967-17900. Oct. 17, 1967. Filed Jan. 17, 1963.

The proposed nuclear-fuel elements, associated with reactor-control rods, have the following advantages: improved neutron economy due to the avoidance of the upper element-supporting plate and the reduction in the spacing between the fuel elements, and prevention of damage to the fuel elements by control rods. A control rod guide plate running to the bottom fuel-element supporting plate is attached onto the outside of the fuel element itself; the control rod moves along this guide plate. (NSA of Japan)

37571 FUEL ELEMENT HEAT TRANSFER ARRANGEMENT. Kornbichler, Heinz (to Licentia Patentverwaltungs GmbH). U. S. Patent 3,384,551. May 21, 1968. Priority date Feb. 17, 1965, Germany.

A cladding arrangement for protecting a tubular fuel element and including an inner jacket covering the inner surface of the fuel element is described. A corrosion resistant metal layer covers the first jacket of zirconium alloy, and a second jacket covers the outer surface of the fuel element. The ends of the fuel elements are plugged with the same zirconium alloy. (auth)

37572 SPACER FOR FUEL ASSEMBLIES. Glandin, Constan; Jansson, Erik Olov (to Allmanna Svenska Elektriska Aktiebolaget). U. S. Patent 3,380,890. Apr. 30, 1968. Priority date Dec. 31, 1964, Sweden.

The description of a nuclear reactor fuel assembly formed from parallel fuel rods and spacers is presented. The spacers each consist of a grid-like body enclosing the fuel rods with spacer springs providing fuel rod support. The spacer springs are permanently attached to the spacer body and are located on two levels of the fuel rods. At each level two springs provide opposing pressure. The springs are wave-formed spring strips. (D.C.C.)

37573 DEVICE FOR DRAWING OUT A RADIOACTIVE SAMPLE. Mazaki, Gango (to Mitsubishi Atomic Power Industries, Inc.). Japanese Patent 1967-24625. Nov. 27, 1967. Filed July 10, 1963.

By the device proposed, a sample irradiated in the reactor core can be drawn out of the core safely enclosed in a shield. The sample holder is connected to its support plug through the mouth pieces attached to the holder and plug. Between the two is a joint on the outside of which are cut grooves for lead and other wires. In this section there also are a shielding body containing the support, and the drive for moving this support back and forward within the body. Located at the position corresponding to the grooves is the shielding cutting mechanism with a cutter to separate the sample holder from its support plug. The sample is finally deposited in a shielded transport container. (NSA of Japan)

37574 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Dent, Kenneth Henry (to United Kingdom Atomic Energy Authority). British Patent 1,118,256. June 26, 1968. Filed Mar. 21, 1966.

The description of a core support for a reactor with a concrete pressure vessel is presented. The core grid and radiation and thermal shields are supported from a central column secured to the base of the concrete pressure vessel. The peripheral support members for the grid allow operational expansion of the grid with lateral shear resistance. (D.C.C.)

37575 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Dabosi, Francis; Mouchnino, Michel; Quere, Yves; Stohr, Jacques Andre (to Commissariat a l'Energie Atomique). British Patent 1,118,282. June 26, 1968. Priority date Aug. 20, 1964, France.

The descriptions of uranium-fueled reactor fuel cans with laminated construction are presented. The cans consist of an outer sheath of Mg-base–Zr alloys and an inner sheath of Mg-base–Al alloys. The effects of ternary additions on the diffusion properties of Pu in the fuel cans are described. (D.C.C.)

37576 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United States Atomic Energy Commission). British Patent 1,118,332. July 3, 1968. Priority date June 7, 1965, United States.

The description of a reactor fuel element for obtaining a thermal expansion coefficient of reactivity approaching zero and facilitating control of the rapidly rising reactivity of a nuclear reactor by use of the Doppler broadening effect is presented. The fuel elements consist of an elongated tubular cladding with closed upper and lower ends. The enclosed fissile fuel zone consists of two to five serially arranged fuel segments. Each segment has one end fixed to the cladding and one end free. The free end is supported by a spring resting against the fixed end of the next fuel segment. The voids formed by the springs allow for thermal expansion. (D.C.C.)

37577 IMPROVEMENTS IN NUCLEAR FUEL ELEMENTS. Campbell, Ronald Hugh (to United Kingdom Atomic Energy Authority). British Patent 1,117,867. June 26, 1968. Filed Oct. 20, 1965.

The description of a PuO_2–UO_2 fuel element penetrated with cooling ducts is presented. The fuel element is fabricated by vibration-compaction of flat cylindrical rings of PuO_2–UO_2. (D.C.C.)

37578 CONTROLLED UNLOADING OF GEOMETRICALLY ORDERED PACKED BEDS. Susskind, H.; Becker, W. W.; Maresca, M. W. (to United States Atomic Energy Commission). U. S. Patent 3,386,627. June 4, 1968.

An ordered packed bed of spherical elements incorporating an arrangement for the controlled and selective unloading of the bed is described. Jets mounted in the side of the bed container inject liquid into the space above the bed at an angle and velocity such as to fluidize the top layer of the bed and carry the particles away. Increasing the jet velocity and using successively lower jets make it possible to remove the bed in sections. (AEC)

37579 IMPROVEMENTS IN NUCLEAR FUEL PINS AND FUEL PIN ASSEMBLIES. Brown, Trevor James; Harrington, Eustace Lionel Ernest (to United Kingdom Atomic Energy Authority). British Patent 1,117,795. June 26, 1968. Filed May 19, 1966.

A method for identifying nuclear reactor fuel pins without visible means is described. Stainless steel plates with punched identifying marks or numbers are secured to the heads of the

fuel pins. As the reactor loading machine removes a fuel pin a magnetic head rotates about the pin for identification. (D.C.C.)

37580 DEVICE FOR SUPPLYING GAS IN THE SCRAM OPERATION OF A SAFETY CONTROL ROD. Suzuki, Yasuyuki (to Fuji Electric Mfg. Co., Ltd.). Japanese Patent 1967-19543. Oct. 2, 1967. Filed Nov. 15, 1965.

The method proposed has the following advantages: simple construction, low cost, and certain operation. The device consists of a piston rod which is connected to a safety control rod; a cylinder containing the piston; a pressure tank connected to the pressure side of the cylinder; a constant-pressure tank to supply pressurized gas to the tank and to control the pressure in the pressure side of the cylinder; a piping connecting the two tanks; a throttle valve installed in the connecting piping; and a pressurized-gas source to supply gas to the constant-pressure tank. (NSA of Japan)

37581 LIQUID-SEALING RELEASE-TYPE (REACTOR) CONTAINMENT VESSEL. Hayashi, Tsutomu (to Hitachi Ltd.). Japanese Patent 1967-15497. Aug. 26, 1967. Filed May 4, 1965.

An improved reactor containment vessel of the "title" type is proposed. The containment vessel is connected to an "outside" tank filled partly with water by a pipe. When the pressure in the containment vessel becomes "negative" after the brief release of a high pressure, in order to limit the rise of water in the connecting pipe, a bypass is connected to the pipe and the excess water is led into the bypass tank. (NSA of Japan)

37582 METHOD FOR ADJUSTING THE REACTIVITY OF A COMBINED-TYPE NUCLEAR REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1967-19540. Oct. 2, 1967. Filed Oct. 26, 1964.

The method proposed has the following advantages: adjustment of the reactivity over the extensive area with a simple mechanism; suitable protection of the reactor; and favorable operation of the reactor. The reactor is divided into a plurality of concentric "nuclear" regions. Between the regions, control rods enter the reactor from the bottom with vertical axial movement. Each control rod is T-shaped in cross section; the plate, corresponding to the upper bar of the T, faces the central nuclear region, and the plate, corresponding to the upright bar, protrudes to the outer region. (NSA of Japan)

37583 REACTOR CONTROL ELEMENT. Sugaya, Junichi (to Hitachi Ltd.). Japanese Patent 1967-17904. Oct. 17, 1967. Filed June 30, 1965.

The reactor control element, from top to bottom, consists of the following: a guide tube; a poison cylindrical-tube and the connected fuel below it; an element support-tube; and a rod running from the guide tube to the support tube through the poison and fuel. By turning a handle attached to the upper end of the guide tube, the poison and the fuel cylinder is raised, being detached from the support tube by means of a hook device released at the lower end of the rod. (NSA of Japan)

37584 RADIOACTIVITY-ADJUSTMENT DEVICE. Seki, Katsuzo (to Hitachi Ltd.). Japanese Patent 1967-17908. Oct. 17, 1967. Filed Feb. 10, 1964.

In detecting the radioactivity of nuclear fuel rods or their damage in the reactor core, the fluid nearby is led to the measuring point outside the reactor through a pipe. A short flexible pipe is set at an appropriate point on the leading pipe; according to the half-life of a particular radionuclide to be measured, this flexible pipe is adjusted with respect to its volume. The result is improved measurement of the radionuclides. (NSA of Japan)

37585 MICROWAVE DIAGNOSIS OF A PLASMA GENERATED IN A REACTOR AND ITS USE AS A REACTOR POWER MONITOR. Voth, M. H.; Kenney, E. S. (Pennsylvania State Univ., University Park). Nucl. Instrum. Methods, 63: 45-52(July 15, 1968).

The plasma produced in a gas filled microwave cavity has been studied by subjecting the cavity to the intense gamma fields present during pulsing operation of a TRIGA nuclear reactor. The cavity studied was designed to serve as an in-core power monitor for extreme power transients and to fulfill the need for a detector of essentially unlimited life. The influence of varying gas pressure and impurity concentration and the effect on sensitivity has been evaluated. High impurity concentrations have been found to greatly influence the cavity performance, reducing free electron densities but improving the response time of the device as a reactor power transient monitor. A prototype device measured gamma ray dose rates from 2×10^8 to 2×10^{10} R/h using natural helium contained in an aluminum cavity. The results are within reasonable agreement with theoretical predictions considering the necessary extrapolation of plasma data. (auth)

37586 REACTOR CONTROL RODS. Sugaya, Junichi (to Hitachi Ltd.). Japanese Patent 1967-17903. Oct. 17, 1967. Filed Jan. 20, 1965.

The method proposed has the following advantages: the possibility of inserting or withdrawing an experimental facility or fuel elements without detaching the plates of control-rod guide tubes, and the compactness and the increased coolant flow. Control rods are located among the fuel elements, and to prevent the abrasion between the fuel element and control rod, a guide tube is provided for the latter. These guide tubes are supported, with respect to one another, by an arrangement of horizontal support rods extending radially from the upper part of the central guide tube. (NSA of Japan)

37587 NUCLEAR FUEL ELEMENTS. Aizu, Tadashi (to Hitachi Ltd.). Japanese Patent 1967-17901. Oct. 17, 1967. Filed Jan. 29, 1963.

The method proposed has the following advantages: easy and firm assemblage with the fuel elements in simple construction, improved neutron economy due to the avoidance of the upper grid plate, and the compactness of the reactor core due to the reduced spacing between the fuel elements. In the assemblage, fuel elements are set vertically onto the bottom grid plate. In the support plate, attached at the upper part of one fuel element, is cut a groove; a two-armed hook is fixed, rotatable at the bend, onto the groove. Then, in the support plate at the adjacent fuel element, is also cut a short groove. The end of one arm engages with the latter groove, while the other arm settles in the former groove, thereby fastening together the two fuel elements; a spring is used to press down the latter arm. (NSA of Japan)

37588 REACTOR CONTAINMENT VESSEL. Hayashi, Tsutomu (to Hitachi Ltd.). Japanese Patent 1967-15498. Aug. 26, 1967. Filed July 7, 1965.

In the reactor containment vessel described the release of an extremely high pressure at the time of an accident is done by means of a liquid. Following the pressure release the containment vessel is shut completely from the outside. A liquid seal room is formed using roughly the lower half of a spherical reactor containment-vessel; the reactor is set on the partitioning floor. The pressure release chamber, filled partly with water, is located at a level higher than the containment vessel. The upper half with the reactor, the lower half containing the seal room, and the chamber are connected in series by piping. After the accident high pressure is released from the chamber, and the pressure in the containment vessel becomes negative. Water in the chamber is drawn and subsequently siphoned down into the liquid seal room. Consequently, the reactor pressure-vessel is completely closed with respect to the atmosphere. (NSA of Japan)

37589 PILE OSCILLATOR. Yoshijima, Shigekazu (to Nippon Atomic Ind. Group Co., Ltd.). Japanese Patent 1967-19546. Oct. 2, 1967. Filed Apr. 24, 1965.

The method proposed has the following advantages: elimination of the background due to the sample container, and non-existence of the transient reactivity change. In the nuclear reactor, a sample material whose neutron-absorption cross section is unknown and the sample whose cross section is known are moved simultaneously in the opposed directions, for the linear part of the statistic weight curve, so that the reactivity change due to the former will be compensated for by the latter. (NSA of Japan)

37590 NUCLEAR REACTOR CORE CONFIGURATION. Jones, Ralph H. (to United States Atomic Energy Commission). U. S. Patent 3,394,049. July 23, 1968.

Fuel elements for a nuclear reactor core which are substantially self-supporting and self-aligning and which may be replaced individually are described. The elements are constructed in the form of a longitudinally elongated trifid having three slab-like fins angularly displaced about and projecting from a common central axial region thus providing for assembly into an interlocking lattice structure adaptable for disposition in varied reactor core configurations. (AEC)

37591 COOLING SYSTEM IN A NUCLEAR REACTOR UTILIZING CONCRETE PRESSURE VESSEL. Hench, John E. (to United States Atomic Energy Commission). U. S. Patent 3,395,075. July 30, 1968.

A cooling system for a nuclear reactor which utilizes a prestressed reinforced concrete pressure vessel is described. An even temperature distribution within and along the inner surface of the pressure vessel is maintained by introducing coolant into the reactor core region through a permeable material barrier disposed between the core and the concrete containment vessel. The coolant flow is in a direction counter to the flow of the heat from the core through the barrier. Therefore the pressure vessel inner surface is contacted only by relatively cold coolant. (AEC)

37592 IMPROVEMENTS IN AND RELATING TO SEALING PACKS OF SHEETS. Armstrong, Edward; McCarthy, Peter James (to Darchem Engineering Ltd.). British Patent 1,115,283. May 29, 1968. Filed Sept. 3, 1965.

The description of a nuclear reactor pressure vessel insulation system is presented. The system consists of multiple metal sheets separated and sealed by V-shaped edges. The marginal areas of the upper part of the sheets are located in pairs in the associated inverted V-shaped recesses. Each sheet has an X-sectioned intermediate strip to straddle the edge and provide an inverted V-shaped recess. (D.C.C.)

37593 NUCLEAR REACTOR FUEL BUNDLE. Bigge, William B.; Roupe, George A. (to General Electric Co.). U. S. Patent 3,382,153. May 7, 1968. Filed Jan. 17, 1966.

The description of a nuclear reactor fuel bundle is presented. The fuel bundle consists of one or more individually removable rods. The removable rod positions are arranged symmetrically with respect to the control rod adjacent the fuel bundle. Depending upon the effect desired, the removable rods may contain fuel of various enrichments, inert material, or neutron absorbing material. (D.C.C.)

37594 LIQUID REFLECTOR CONTROL FOR NUCLEAR REACTORS. Ackroyd, Ronald Tunstall; Perks, Maurice Arthur (to United Kingdom Atomic Energy Authority). U. S. Patent 3,383,285. May 14, 1968. Priority date Dec. 23, 1965, Great Britain.

A nuclear reactor having a core surrounded by a segmented reflector is described. Reactivity control in the reactor is obtained by altering the reflector geometry. The reflector segments are extended in juxtaposed relationship from top to bottom, and the liquid level in each segment is regulated by gas pressure. The reflector may carry fertile material and is in the liquid metal form. (D.C.C.)

37595 IMPROVEMENTS IN AND RELATING TO METAL-LINED, CONCRETE PRESSURE VESSELS. Chapman, John Clifford; Carter, Alan; Phillips, Arnold Boyd (to Atomic Power Constructions Ltd.). British Patent 1,116,327. June 6, 1968. Filed Jan. 13, 1967.

A metal-lined concrete pressure vessel is described. The metal lining is flexible and forms a fluid tight container. Connector members from the interior side of the pressure vessel are secured to the metal lining. The members yield under load to allow for variations in shape or size of the concrete pressure vessel. The connector members consist of rows of metal loops and flexible studs. Coolant pipes serve to regulate the metal lining temperatures. (D.C.C.)

37596 IMPROVEMENTS RELATING TO ROTARY BEARING ARRANGEMENTS FOR LARGE HEAVY OBJECTS, FOR EXAMPLE ROTATABLE SECTIONS OF SHIELDING IN NUCLEAR REACTORS. Gregson, John (to Fairey Engineering Ltd.). British Patent 1,116,402. June 6, 1968. Filed Nov. 22, 1963.

The description of a rotary hydrostatic bearing arrangement is presented. The bearing system consists of spaced cooperating bearing members exposing coaxial surfaces of revolution. The bearing surfaces are shallow recesses with throttling restrictors to supply high-pressure hydraulic liquid. The hydraulic liquid supports the bearing load and maintains a space between surfaces. An internal circumferential weir and an external circumferential weir maintain a head of trapped liquid in the space between the weirs and the bearing forming a continuous circumferential gas seal. (D.C.C.)

37597 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Cocker, Peter; Cookson, William Francis (to United Kingdom Atomic Energy Authority). British Patent 1,113,465. May 15, 1968. Filed Feb. 11, 1966.

The description of a nuclear reactor fuel assembly is presented. The fuel assembly consists of a cluster of parallel fuel rods arranged in an end-to-end configuration to form a unitary assembly. The fuel rods are connected and disconnected by a deformable latch at the top of the fuel rod and a non-deformable latch at the bottom of the fuel rod. A locking device consists of a lifting member which extends longitudinally the entire length of the assembly. (D.C.C.)

37598 NUCLEAR FUEL ELEMENTS. (to Minnesota Mining and Mfg. Co.). British Patent 1,115,452. May 29, 1968. Priority date July 9, 1964, United States.

The description of a laminated fuel element of one or more unitary sintered refractory metal sheets is presented. Particles of actinide fuel are uniformly dispersed in the metal sheets. The metals used are stainless steel, Cr, Fe, Mo, Nb, Ni, Ta, Ti, W, V, and Zr. Fuel containing sheets with an organic binder are laminated between sheets containing no fuel particles. (D.C.C.)

37599 DRIVE MECHANISM FOR EFFECTING A VERTICAL RECTILINEAL MOVEMENT. Gerard, Victor; Paloma, Georges (to Commissariat a l'Energie Atomique). British Patent 1,113,736. May 15, 1968. Priority date Aug. 26, 1965, France.

A control rod drive mechanism is described. The mechanism provides for a vertical rectilineal movement of small amplitude. The mechanism consists of a rod connected to the control element, a guide tube placed around the rod and secured by an electromagnet, and a drive device. The drive mechanism uses a helical groove to transmit rotation into vertical movement. The helical groove is of variable pitch. The control rod is spring driven when released from the electromagnet lock. (D.C.C.)

37600 NUCLEAR REACTOR WITH SOLID SUBSTANCE MODERATOR OF VARIABLE SLOWING-DOWN POWER. Rolf Schlottau. British Patent 1,114,285. May 22, 1968. Priority date Sept. 17, 1964, Germany.

The description of a reactor with solid variable slowing-down property moderators is presented. The stepwise or continuous reactivity change in the reactor is accomplished by the use of zirconium hydride and zirconium deuteride rods to alter the hydrogen-deuterium ratio. (D.C.C.)

37601 IMPROVEMENTS IN OR RELATING TO A FUEL ELEMENT ASSEMBLY FOR A NUCLEAR REACTOR. (to Atomic Energy Board). British Patent 1,114,567. May 22, 1968. Filed June 10, 1965.

The description of a fuel element support system is presented. The system consists of reactor core heating and cooling means to alternately melt and freeze coolant in the form of fuel channel plugs. This allows the batchwise removal of spent fuel from the reactor core. (D.C.C.)

37602 IMPROVEMENTS IN AND RELATING TO NUCLEAR FUEL CARTRIDGES. Gauthron, Maurice (to Commissariat a l'Energie Atomique). British Patent 1,113,187. May 8, 1968. Priority date Apr. 1, 1966, France.

The description of a nuclear fuel cartridge is presented. The cartridge consists of a tube of fuel material enclosed in a metal can with end-plugs, a central rod of solid compatible material extending through the length of the fuel material to transmit axial forces, and a cap at each end of the central rod. The cartridge configuration allows stacking of similar cartridges in vertical arrangement. (D.C.C.)

37603 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Ashcroft, David John; Timbs, Arthur Edwards (to United Kingdom Atomic Energy Authority). British Patent 1,112,946. May 8, 1968. Filed Aug. 10, 1965.

The description of a reactor fuel element support grid is presented. The grid consists of a saucer plate with symmetrically spaced openings for resilient inserts. The inserts contain the fuel pins. The inserts are supported by three equi-spaced barrel-shaped lobes which allow coolant flow between the grid and inserts. The inserts have three sets of equi-spaced tabs between the lobes to locate the insert position. (D.C.C.)

37604 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Gittus, John Henry (to United Kingdom Atomic Energy Authority). British Patent 1,112,579. May 8, 1968. Filed Sept. 17, 1964.

The description of a pellet-type fuel assembly is presented. The fuel assembly is constructed from two sets of parallel equi-spaced walls. The sets are arranged to intersect at right angles. The configuration of parallel and intersecting walls is accomplished by L- and T-shaped pellets. (D.C.C.)

37605 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Cookson, William Francis; Cocker, Peter (to United Kingdom Atomic Energy Authority). British Patent 1,113,466. May 15, 1968. Filed Feb. 11, 1966.

The description of a cluster-type fuel element is presented. The fuel element consists of multiple rods enclosed in a cylindrical sleeve. The fuel element is designed for end-to-end placement in a reactor core fuel channel. The elements are sealed by corrugated sealing rings located in multiple grooves on the bottom of the fuel element. The receptacle for the sealing device is located in the top of the fuel element. (D.C.C.)

37606 ACCESS DUCT FOR A NUCLEAR REACTOR. Milner, Malcolm John; Haikney, Alan (to English Electric Co. Ltd.). British Patent 1,115,476. May 29, 1968. Filed Nov. 25, 1964.

The description of an access duct for a concrete pressure vessel-enclosed reactor is presented. The duct has a water-

cooled sleeve. An enclosure extending into the open-ended duct is surrounded by vermiculite insulation. (D.C.C.)

37607 NUCLEAR REACTOR CORE CLAMPING SYSTEM. (to United States Atomic Energy Commission). British Patent 1,115,492. May 29, 1968. Priority date Feb. 19, 1965, United States.

The description of a clamping system for the core of a nuclear reactor is presented. The system consists of an upper clamping ring, a lower clamping bearing surface, multiple clamping elements surrounding the circumference of the core, and torsion rods for actuating the clamping elements motion. Upper and lower clamping elements are actuated in opposite directions by the torsion rod movement. (D.C.C.)

37608 CHANNEL FOR A NUCLEAR REACTOR. Haegel, Etienne; Malaval, Claude (to Commissariat a l'Energie Atomique). British Patent 1,115,836. May 29, 1968. Priority date July 13, 1965, France.

The description of a fuel channel for heavy water-cooled reactors is presented. The fuel channel consists of a circular bottom section for centering the fuel elements, a polygonal central portion, a top tubular portion with a removable biological shielding plug for loading the fuel elements, and coolant flow deflectors. A coolant sampling tube is located in the top portion of the channel. (D.C.C.)

37609 IMPROVEMENTS IN OR RELATING TO INTEGRAL NUCLEAR REACTORS. (to Babcock and Wilcox Ltd.). British Patent 1,115,898. May 29, 1968. Priority date Mar. 2, 1966, Germany.

The description of an integral nuclear reactor circulating pump is presented. The pump system consists of an externally located drive system, a sleeve penetrating the pressure vessel, a drive shaft enclosed in the sleeve, and an impeller extending into the pressure vessel. The blades on the impeller have a larger circle of rotation than the entrance sleeve radius. Therefore, the blades are pivotally mounted at the drive shaft and are placed in a folded position when entering or leaving the pressure vessel. The blades are opened by a conical wedge moving axially against the spring-tensioned drive shaft hub. (D.C.C.)

37610 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Martin, Frederick Samuel (to United Kingdom Atomic Energy Authority). British Patent 1,115,153. May 29, 1968. Filed Nov. 9, 1964.

The description of fuel rod assemblies is presented. The fuel rods consist of circular and hexagonal cross section ceramic dispersion-type tubular elements. The rods are arranged in clusters of various patterns with cross sectional voidage for coolant flow. (D.C.C.)

37611 NUCLEAR REACTOR CORE SUPPORT STRUCTURE. Jackson, George Oliver (to United Kingdom Atomic Energy Authority). U. S. Patent 3,383,287. May 14, 1968. Priority date June 15, 1965, Great Britain.

Support structures for fuel assemblies composed of a casing containing fuel rods, reflector, and breeder are described. The structures support the fuel assemblies in cantilever fashion at the lower ends. The end fittings of the assemblies are inserted in sockets in the support structure. A pair of bearing surfaces in each socket co-operate with a complementary pair of bearing surfaces on the respective end fitting, and the surfaces of one of the pairs are in slight axial misalignment to impose a little tilting on the assembly. The assemblies are in groups around vertical structural members and the tilting is towards the vertical members to achieve firm engagement with the member. (auth)

37612 CONCRETE CONTAINMENT VESSEL. (to U. S. Atomic Energy Commission). British Patent 1,113,098. May 8, 1968. Priority date Jan. 11, 1965, United States.

The description of a concrete reactor containment vessel is presented. The containment vessel has a hollow interior with multiple metallic reinforcing rods extending in the form of closed loops through the concrete mass. The rods are covered with jackets. The top of the containment vessel is open and the bottom is closed. A metal cover for the top is fastened to the concrete vessel by the jacket-covered rods. (D.C.C.)

37613 USE OF GAMMA RADIATION RESPONSIVE GAS IONIZED BY GAMMA RADIATION IN A NUCLEAR REACTOR AND MEASURING THE GAMMA RADIATION IONIZATION EFFECTS. Goldstein, Ladislas; Adler, Felix T. (to Univ. of Illinois Foundation). U. S. Patent 3,383,509. May 14, 1968. Filed Nov. 29, 1965.

A gas-filled cavity for in-core determination of power levels in reactors is described. The gamma radiation in the reactor ionizes the gas and produces a plasma the electron density of which is measured by standard microwave and laser interferometer techniques. The value of the electron density being in direct proportion to the power level of the reactor. (B.G.D.)

37614 EXPERIMENTAL BOILING STUDIES WITH SODIUM UP TO 900°C. Pinchera, G. C.; Tomassetti, G.; Farello, G. E. (CNEN, Rome). Calore, 39: 193-203(1968). (In Italian).

The research program ENA is aimed to study, experimentally and theoretically, the behaviour of sodium during reactor accidents that lead to the coolant boiling in a simulated cluster of rods. The development of an instrumented simulated fuel rod is described. During the boiling of sodium on the surface of a vertical cylindrical heater steady state boiling curves and power transient liquid superheats were measured as a function of system pressure, surface finish and history. Transient tests give very different superheat values; generally up to 10°C wall superheat for rough surfaces and up to 60°C liquid superheat for as received surfaces. Initial transient boiling studies in a water analog forced convection loop are described. (auth)

37615 CALIBRATION OF AN EPITHERMAL LOCAL PILE OSCILLATOR. Dekker, A. L.; Koetsier, A. H. (Technological Univ., Delft, Netherlands). Nucl. Instrum. Methods, 62: 301-5 (July 1, 1968).

A description is given of the calibration of a local pile oscillator for epithermal neutron absorption. The nuclide ^{197}Au is used as a standard in a gold-lead alloy. First the neutron absorption of the standards is determined by activation analysis and compared to computations. Thereafter the calibration is performed by oscillating these standard samples. A linear relationship is found between the number of absorbed neutrons in the sample and the oscillator results. (auth)

37616 HOW DO YOU ACCOUNT FOR NUCLEAR FUEL. Elec. World, 169: 113-16(Feb. 5, 1968).

A basic accounting unit for recording nuclear fuel from the initial point of active use in a reactor to the point of salvage is discussed. Identification of fuel assemblies by isotopic content before and after reactor use is described. Methods for accurate accounting of fuel for economic balances are presented. (D.C.C.)

37617 CONDENSATION OF CESIUM IN COATED PARTICLES. Luhleich, H.; Penndorf, K.; Suetterlin, L. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt, Geesthacht, Ger.). Atomkernenergie, 13: 171-5(May-June 1968). (In German).

Liquid cesium corrodes graphite. Therefore, the problem is handled theoretically of whether the fission product cesium will become liquid and at what time this will occur in coated particles. Burn up is estimated and fuel lifetimes are calculated for determining the beginning of condensation of cesium in coated particles. It is shown that cesium becomes liquid at a time that is short compared with usual fuel lifetimes of HTGRs. (auth)

37618 CALCULATION OF REGION-DEPENDENT THERMAL NEUTRON SPECTRA BY THE MONTE CARLO CODE MEGMOC. Lahann, H.-J.; Mertins, H. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie, 13: 177-82(May-June 1968).

The thermal neutron distribution for a square water moderated lattice and a hexagonal lattice with $ZrH_{1.7}$ as moderator are determined. As an approximation the scattering is treated isotropic with the use of various transport kernels. (auth)

37619 AN ADVANCEMENT IN NEUTRON TRANSPORT THEORY. PART 2. IMPROVEMENT IN THE CLASSIC DIFFUSION COEFFICIENT FORMULATION. Michelini, M. (CNEN, Rome). Energ. Nucl. (Milan), 15: 441-9(July 1968).

On the basis of the analysis carried out in Part 1, the classic formulation of the neutron current (corrected by the 3rd derivative) is extended to very thin regions surrounded by large media. An improved formulation of the diffusion coefficient depending on the size of each region is then built up, which allows the prediction of more accurate flux distributions. (auth)

37620 A RAMP GENERATOR FOR VERY LONG PERIODS. Greinevitch, T. A.; Hassan, M. A. (KAR Atomic Energy Establishment, Cairo). Atomkernenergie, 13: 303(1968).

A ramp generator circuit capable of periods up to 15 minutes, an output voltage swing of 3 to 8 volts, and linearity of 1 to 2% is described. (H.D.R.)

37621 EXPERIMENTAL TECHNIQUE TO PREDICT POWER DISTRIBUTION IN FUEL IRRADIATION EXPERIMENTS. Bozzi, L.; Gibello, A.; Pugnetti, G. (CNEN, Rome). Energ. Nucl. (Milan), 15: 322-9(May 1968).

An experimental technique used for determining power distribution in cylindrical fuel rods is described. It involves a direct counting of UO_2 pellets, irradiated at low reactor power, for deter-

mining the axial heat generation rate, and an instrumental analysis of the radial fission product concentration in the individual specimens for the detection of the specific power distribution. A description of the microdrilling technique applied for precision sampling of the fuel specimens is also included. Some experimental results are presented and briefly discussed. (auth)

37622 AN ADVANCEMENT IN NEUTRON TRANSPORT THEORY. PART 1. POSSIBILITIES OF NUMERICAL SOLUTION OF NEUTRON TRANSPORT IN INHOMOGENEOUS MEDIA. Michelini, M. (CNEN, Rome). Energ. Nucl. (Milan), 15: 389-95(June 1968).

A general procedure is developed which enables neutron transport problems in inhomogeneous media by means of a linear differential equation for the scalar flux to be solved. The coefficients of this equation can be easily computed by multigroup diffusion calculations. Indications are given on the degree of accuracy of these diffusion calculations. An application to lattices consisting of thin regions is numerically carried out. (auth)

GENERAL

37623 (AD-665307) REPAIR AND RECLAMATION OF GAS AND ELECTRIC UTILITY SYSTEMS. Final Report. Van Horn, William H.; Boyd, Gail B.; Foget, Carl R. (URS Corp., Burlingame, Calif.). July 1967. 140p. (URS-669-6). CFSTI.

The study was directed toward identifying the essential subsystems and components of metropolitan gas and electric utility systems, determining their functional relationships, estimating the damage to critical elements from various nuclear weapons effects, and estimating the repair requirements for restoring damaged systems. A mathematical repair model was developed and applied to 'typical' city, and from the results of the study, time repair effort including manpower by skills, was derived. The major findings of the report are: (1) Being located primarily below ground and comprised of elements having great structural strength, metropolitan gas utility systems tend to be much less vulnerable to weapon damage than electric utility systems. Further, gas system installations are generally less complex in design and function and, therefore, impose smaller and less stringent repair requirements in terms of manpower, skills, equipment, spare parts, and materials. (2) The level of damage, expressed as overpressure (and related weapon effects) can be related to repair effort by an experimental function. This mathematical repair model can be used to predict repair requirements (including men and materials under various assumed attack conditions) for real utilities and real cities. (auth) (USGRDR)

37624 (AWRE/LIB/BIB-17) LIST OF UNCLASSIFIED PUBLICATIONS AND AWRE REPORTS BY STAFF OF THE WEAPONS GROUP PUBLISHED DURING THE YEAR 1967. Every, R. S. (comp.) (Atomic Weapons Research Establishment, Aldermaston (England)). Apr. 1968. 38p. Dep. CFSTI. UK 5s. 6d.

A list of 143 references to reports and publications issued in 1967 in the fields of chemistry, instrumentation, health and safety, isotope separation, metallurgy and materials, solid-state physics, nuclear and theoretical physics, plasma physics, particle accelerators, and reactor physics and technology by the staff of the Weapons Group UKAEA Atomic Weapons Research Establishment are presented. An author index is included, and a list of omissions from a previous list (AWRE/LIB/BIB-16) is appended. (W.H.K.)

37625 (BNL-50104) COMPUTATION OF CONTINUOUS DECOMPRESSION SCHEDULES FOR DEEP SEA DIVES. Robertson, James S. (Brookhaven National Lab., Upton, N. Y.); Moeller, George (Naval Submarine Medical Center, Groton, Conn. Submarine Medical Research Lab.). Mar. 1968. 37p. (NSMC-517). Dep. CFSTI.

A digital computer program for calculating either continuous ascent or stop-type decompression schedules is described, and examples of applications are given. The formulas used for continuous ascent were obtained analytically as solutions of differential equations relating the inert gas tension in the current critical tissue to the safe depth and with the actual depth kept equal to the safe depth at all times after an initial fast rise from the bottom to the safe depth. Thus the rate of decompression of the critical tissue controls the rate of ascent. Gas tensions in nine tissues having the same range of gas exchange half-times as have been used in EDU reports are calculated on a continuous basis, with the one having the deepest safe depth being the current critical tissue. The stop-type ascent portion of the program may be used to generate a staged ascent using the same parameters for comparison with the continuous ascent schedule. The starting conditions for ascent may either be computed by the program from the dive history or be communicated to it as a subroutine in connection with another program. The program may be used either to prescribe ascent schedules or to analyze dives for which the history is known. (auth)

37626 (BNWL-765) MULTICHANNEL EDDY CURRENT TUBING TESTER. Libby, H. L.; Wandling, C. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 28, 1968. Contract AT(45-1)-1830. 30p. Dep. CFSTI.

A two channel, two frequency, eddy current, tubing nondestructive test device is described in which the undesirable effect of test probe wobble signals is reduced on both channels. A novel analyzer circuit or signal transformation section is used for the successive elimination of parameters. The tester is flexible in operation and can be operated using either of its two test frequencies, 100 and 300 kHz singly, or both simultaneously. When operated in its single frequency modes, two test parameters, for example probe wobble, and the presence of defects giving signals having components in quadrature with probe wobble signals may be separated. When operated in its two frequency mode the effects of one test parameter can be minimized and the effects of two other test parameters may be read out. Instrument test results for the two frequency mode of operation are shown in which probe wobble signals are minimized on both of the two output channels and signals due to defects opening on the inner wall of the tubular test specimen appear on one channel, and signals due to defects opening on the outer wall of the specimen appear on the other channel. (auth)

37627 (EGG-1183-1381) HIGH RESOLUTION TDR CABLE MEASUREMENT TECHNIQUES. Technical Report Number L-894. Phillips, R. W.; Stoessner, R. D. (EG and G, Inc., Las Vegas, Nev.). May 15, 1968. Contract AT(29-1)-1183. 67p. Dep. CFSTI.

High resolution cable time domain reflectometry techniques that may be used to measure signal cable transit times, time differences and impedance of long lengths of coaxial cable are presented. A very fast rise, short duration pulse is transmitted down a coaxial cable. The reflection from the undetermined cable end is observed on a sampling oscilloscope and recorded. To preserve the time scale on the strip chart recording, an rf oscillator signal is recorded simultaneously with the pulse reflection information. The oscillator, pulse generator, and oscilloscope are described. (W.H.K.)

37628 (ISS-68/1) IL SEMINARIO DEI LABORATORI DI FISICA NEL QUADRIMESTRE SETTEMBRE-DICEMBRE 1967. (Seminars of the Physics Laboratory in the Quarter September-December 1967). (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Jan. 3, 1968. 57p. (In Italian and English). Dep.

A synopsis of the lectures held at the Physics Laboratory of the Istituto Superiore di Sanità during the period September to December 1967 is presented. (auth)

37629 (LA-3877) SUBROUTINES FOR COMPUTING AND GRAPHING LEVEL LINES OF FUNCTIONS OF TWO VARIABLES. Lewis, H. Ralph (Los Alamos Scientific Lab., N. Mex.). Mar. 1965. Contract W-7405-eng-36. 10p. Dep. CFSTI.

FORTRAN subroutines for computing and graphing level lines of an arbitrary function of two variables are described. Instructions for using the subroutines are presented with an example and listings of the computer programs. (auth)

37630 (LA-3928) THE ELECTROLYTIC OXIDATION OF CARRIER-FREE ^{131}I. Jackson, Darryl D. (Los Alamos Scientific Lab., N. Mex.). Apr. 1968. Contract W-7405-eng-36. 143p. Dep. CFSTI.

Solutions of carrier-free iodate-131 were prepared by electrolytic oxidation of iodide-131 in 0.01 M sodium bicarbonate solution at a graphite anode. The minimum anode potential necessary to carry out the oxidation was +0.79 volt vs. S.C.E. (standard calomel electrode); above this the rate of the oxidation increased with increasing anode potential. The rate of the oxidation, in terms of the iodide fraction, was relatively independent of the total initial iodide concentration indicating that the reaction followed the first order rate law over the concentration range studied (carrier-free to 10^{-4} M iodide). No evidence for the formation of periodate could be found when carrier-free iodide-131 in sodium bicarbonate or sodium carbonate solution was electrolyzed at anode potentials of up to +1.90 volts vs S.C.E. Several iodine species were produced when carrier-free iodide-131 in 0.01 M sulfuric acid solution was electrolyzed at a graphite anode. At anode potentials of +0.900 and +1.000 volt vs. S.C.E. a large fraction of the iodine was converted to species extracted by benzene but not back-extracted by aqueous iodide. At +1.500 volts vs. S.C.E. the activity was oxidized to iodate. An all electronic potentiostat with good response time was designed and constructed from commercially available units. The potential of the controlled electrode could be varied over a range of ±2 volts vs. the reference electrode and the regulation was better than ±1 millivolt. (auth)

37631 (ORNL-4261) TABLES OF ARITHMETICAL FUNCTIONS RELATED TO THE FIBONACCI NUMBERS. Hannon, Beth H.; Morris, William L. (Oak Ridge National Lab., Tenn.). June 1968. Contract W-7405-eng-26. 59p. Dep. CFSTI.

Tables of five arithmetical functions related to the Fibonacci numbers are presented. Function values are given for all arguments up to and including 15,600. Since two of these functions have only recently been discovered, these tables are essentially new. (auth)

37632 (RFP-1034) STUDY OF FREQUENCY RESPONSE OF SHEFFIELD ELECTROJETS. Jacobson, Charles H.; Moore,

Robert R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). June 10, 1968. Contract AT(29-1)-1106. 3p. Dep. CFSTI.

Experiments were undertaken to test the limits of frequency response in a Sheffield Electrojet device. Specific application related to measurement of lathe spindle runout at high speeds (about 2000 revolutions per minute). Findings show the response will be accurate to driving frequencies of 30 cycles per second, as compared to normally used maximums of one cycle per second. Such capability suggests possible applications in other related work efforts. (auth)

37633 (RFP-1107) MOLE REACTION: FORTRAN-IV DATA REDUCTION PROGRAM FOR GAS-GAS AND GAS-SOLID REACTIONS. Loser, Robert W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). May 21, 1968. Contract AT(29-1)-1106. 14p. Dep. CFSTI.

The Mole Reaction–FORTRAN IV program represents a comprehensive evaluation of gas pressure data from gas-gas and gas-solid reactions. The program reduces the pressure, volume, temperature and sample volume, and the composition data to give the rate of change in the concentration of residual gases in a reaction and the total change in moles of each gas for a number of reactions. From the initial reactant and temperature-dependent input data, the reactions are evaluated by gas law equations and the formation or consumption of key gases is presented. (auth)

37634 USE AND POSSESSION OF NUCLEAR MATERIAL. Santarelli, Enrico. Ing. Nucl., 8: No. 6, 41-52(Nov.-Dec. 1967). (In Italian).

Some of the most important aspects of the administration of nuclear material are reviewed. The principal accords and regulations on the use and possession of nuclear materials are outlined. The guiding provisions, particularly the American provisions and their effects, are discussed. (J.S.R.)

37635 NUCLEAR ENGINEERING AND NUCLEAR CHEMICAL ENGINEERING. AN ARTICLE ON TERMINOLOGY. Mardus, G. Atomkernenergie, 13: 223-6(May-June 1968). (In German).

Following an introductory note on the significance of the characterization, definition and structure of technical branches in general, the boundaries of engineering are defined. The engineering activities to which nuclear physics have given birth are enumerated in the form of a historical survey and their genetic terms (nuclear engineering, nuclear chemical engineering) and common features are named. Nuclear engineering is then defined and explained, after which a description, definition and characterization of chemical engineering is given. A comparison of nuclear engineering and chemical engineering shows that only certain aspects of nuclear engineering can be classified as nuclear chemical engineering. Nuclear engineering represents a separate sphere and its name is well-chosen. In conclusion, nuclear engineering is classified into sub-branches in two different ways. (auth)

Appendix 1

JOURNAL LIST

The following list includes 1968 additions to the comprehensive list published in NSA, Volume 22, No. 1, January 15, 1968. In the future, comprehensive lists will be published once each year (in January), and current additions will be cumulated on a monthly basis (in alternate issues) until the next comprehensive list is issued.

The title abbreviations are based on the United States of America Standards Institute's REVISED AND ENLARGED WORD-ABBREVIATION LIST FOR USASI Z39.5–1963 AMERICAN STANDARD FOR PERIODICAL TITLE ABBREVIATIONS. Titles of journals that are scanned regularly for NUCLEAR SCIENCE ABSTRACTS are marked by an asterisk (*). Foreign-language journals identified by a dagger (†) are available in English translation. The original-language title for a translated journal is given in parenthesis after the English title.

Accounts Chem. Res.
*Accounts of Chemical Research *(U. S.)*
Acta Anat. Nippon.
Acta Anatomica Nipponica
see Kaibogaku Zasshi
Acta Astron.
Acta Astronomica, Polska Akademia Nauk (formed by merger of Acta Astronomica, Ser. A; Ser. B; and Ser. C) *(Poland)*
Acta Entomol. Bohemoslav.
Acta Entomologica Bohemoslovaca *(Czechoslovakia)*
Acta Geod., Geophys. Montanistica
Acta Geodaetica, Geophysica et Montanistica *(Hungary)*
Acta Med. Iugoslav.
Acta Medica Iugoslavica *(Yugoslavia)*
Acta Pharm. Hung.
Acta Pharmaceutica Hungarica *(Hungary)*
Acta Pharm. Suec.
Acta Pharmaceutica Suecica *(Sweden)*
Acta Phys. Chem.
*Acta Physica et Chemica *(Hungary)*
Acta Polytech., Chem. Met. Ser.
Acta Polytechnica, Chemistry including Metallurgy Series *(Sweden)*
Acta Sci. Natur. Univ. Pekin.
Acta Scientiarum Naturalium Universitatis Pekinensis
see Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Acta Tuberc. Pneumol. Belg.
Acta Tuberculosea et Pneumologica Belgica *(Belgium)*
Acta Univ. Carolinae, Med., Monogr.
Acta Universitatis Carolinae, Medica, Monographia *(Czechoslovakia)*
Acta Univ. Nankinensis Sci. Natur.
Acta Universitatis Nankinensis Scientiarum Naturalium
see Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Acta Univ. Upsaliensis, Abstr. Upsala Diss. Sci.
Acta Universitatis Upsaliensis, Abstracts of Upsala Dissertations in Science *(Sweden)*
Advan. Contr. Syst.
Advances in Control Systems *(U. S.)*
Advan. Cryog. Eng.
Advances in Cryogenic Engineering *(U. S.)*
Advan. Nucl. Phys.
Advances in Nuclear Physics *(U. S.)*
Advan. Polym. Sci.
Advances in Polymer Science
see Fortschr. Hochpolym.-Forsch.
Advan. X-Ray Anal.
Advances in X-Ray Analysis *(U. S.)*
Aesthet. Med.
Aesthetische Medizin *(West Germany)*
Agr. Hokkaido
Agriculture in Hokkaido
see Hokuno
Agr. Res. (New Delhi)
Agricultural Research (New Delhi) *(India)*
Air Clean.
Air Cleaning
see Kuki Seijo
Air Water Pollut.
*Air and Water Pollution (formerly International Journal of Air Water Pollution) *(U. S.–England)*
Ala. J. Med. Sci.
Alabama Journal of Medical Sciences, The *(U. S.)*
Allg. Prakt. Chem.
Allgemeine und Praktische Chemie *(Austria)*
Allg. Waermetech.
Allgemeine Waermetechnik *(West Germany)*
Alloy Dig. Zr-3
Alloy Digest Zr-3 *(U.S.)*
Amer. Dyestuff Rep.
American Dyestuff Reporter *(U. S.)*
Amer. Mach./Metalwork. Mfg.
American Machinist/Metalworking Manufacturing *(U. S.)*
Anal. Lett.
Analytical Letters *(U. S.)*
Ann. Acad. Sci. Fenn., Ser. A IV
Annales Academiae Scientiarum Fennicae, Series A IV *(Finland)*
Ann. Bot. Fenn.
Annales Botanici Fennici *(Finland)*
Ann. Dent.
Annals of Dentistry *(U. S.)*
Ann. Ponts Chaussees
Annales des Ponts et Chaussees *(France)*
Annu. ISA (Instrum. Soc. Amer.) Conf. Proc.
Annual ISA (Instrument Society of America) Conference Proceedings *(U. S.)*
Ann. Univ. Mariae Curie-Sklodowska, Lublin-Pol., Sect. DD
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio DD *(Poland)*
Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Geol.
*Annales Universitatis Scientiarum Budapestinensis de Rolando Eotvos Nominatae, Sectio Geologica *(Hungary)*
Annu. Rep. Res. Inst. Environ. Med., Nagoya Univ.
Annual Report of the Research Institute of Environmental Medicine, Nagoya University *(Japan)*
Annu. Rev. Genet.
Annual Review of Genetics *(U.S.)*
An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.
Analele Universitatii Bucuresti, Seria Stiintele Naturii, Fizica *(Romania)*
Apicultura (Bucharest)
Apicultura (Bucharest) *(Romania)*
Arbeitsgemeinsch. Forsch. Landes Nordrhein-Westfalen
Arbeitsgemeinschaft fuer Forschung des Landes Nordrhein-Westfalen *(West Germany)*
Arbeitsmed.-Sozialmed.-Arbeitshyg.
Arbeitsmedizin-Sozialmedizin-Arbeitshygiene *(West Germany)*
Arch. Hist. Exact. Sci.
Archive for History of Exact Sciences *(West Germany–U. S.)*
Arch. Jap. Chir.
Archiv fuer Japanische Chirurgie
see Nippon Geka Hokan
Arch. Meteorol., Geophys. Bioklimatol., Ser. B

Archive fuer Meteorologie, Geophysik und Bioklimatologie, Series B *(Austria)*

Arch. Mineral.
Archiwum Mineralogiczne *(Poland)*

Arch. Neer. Sci. Exactes Natur.
Archives Neerlandaises des Sciences Exactes et Naturelles *(Netherlands)*

Arch. Stomatol.
Archivio Stomatologico *(Italy)*

Ark. Zool.
Arkiv for Zoologi, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*

ASM (Amer. Soc. Metals), Trans. Quart.
*ASM (American Society for Metals), Transactions Quarterly (formerly Transactions of the American Society for Metals) *(U. S.)*

ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.
ASTM (American Society for Testing and Materials) Special Technical Publication *(U. S.)*

Astrofizika
Astrofizika *(Armenian S.S.R.)*

Astron. Tsirk.
Astronomicheskii Tsirkulyar *(U.S.S.R.)*

Astrophys. Lett.
*Astrophysical Letters *(Scotland)*

Astrophys. Space Sci.
*Astrophysics and Space Science *(Netherlands)*

At. Absorption Newslett.
Atomic Absorption Newsletter *(U. S.)*

At. Energy (China)
Atomic Energy (China)
see ***Yuan Tzu Neng***

At. Energy Law J.
Atomic Energy Law Journal *(U. S.)*

Atmos. Environ.
*Atmospheric Environment *(England)*

Aust. J. Mar. Freshwater Res.
Australian Journal of Marine and Freshwater Research *(Australia)*

Aust. J. Zool.
Australian Journal of Zoology *(Australia)*

Aust. Mach. Prod. Eng.
Australian Machinery and Production Engineering *(Australia)*

Australas. Mfr.
Australasian Manufacturer *(Australia)*

Automat. Electron.
Automatica si Electronica *(Romania)*

Automaz. Strum.
Automazione e Strumentazione *(Italy)*

Aviat. Week Space Technol.
Aviation Week and Space Technology *(U. S.)*

Bautechnik
Bautechnik, Die *(West Germany)*

Beitr. Biol. Pflanz.
Beitraege zur Biologie der Pflanzen *(West Germany)*

Ber. Deut. Ges. Geol. Wiss., Reihe B
Berichte der Deutschen Gesellschaft fuer Geologische Wissenschaften, Reihe B. Mineralogie und Lagerstaettenforschung *(East Germany)*

Berg- Huettenmaenn. Monatsh. Montan. Hochsch. Leoben
Berg- und Huettenmaennische Monatschefte der Montanistischen Hochschule in Leoben *(West Germany)*

Berlin. Wetterkarte, Suppl.
Berliner Wetterkarte, Supplement *(West Germany)*

Beton Zhelezobeton
Beton i Zhelezobeton *(Georgian S.S.R.)*

Biol. Rundsch.
Biologische Rundschau *(East Germany)*

Blech
Blech *(West Germany)*

BNX Rev.
BNX Review *(England)*

Bodenkultur
Bodenkultur, Die *(Austria)*

Boll. Zool.
Bollettino di Zoologia. Pubblicato dall'Unione Zoologica Italiana *(Italy)*

Bol. Univ. Fed. Parana, Fis. Teor.
*Boletim da Universidade Federal do Parana, Fisica Teorica *(Brazil)*

Brain Res.
Brain Research *(Netherlands)*

Brit. Food J.
British Food Journal *(England)*

Brit. J. Plast. Surg.
British Journal of Plastic Surgery *(Scotland)*

Brit. Mycol. Soc. Trans.
British Mycological Society Transactions, The *(England)*

Brit. Plast.
British Plastics *(England)*

Build. Eng.
Building Engineering
see ***Kenchiku Gijutsu***

Bull. Astron.
Bulletin Astronomique *(France)*

Bull. Astron. Inst. Neth., Suppl. Ser.
Bulletin of the Astronomical Institutes of the Netherlands, Supplement Series *(Netherlands)*

Bull. Belgicatom
Bulletin Belgicatom (formerly Belgicatom, Association Belge pour le Developpement Pacifique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*

Bull. Belg. Phys. Soc.
Bulletin of the Belgian Physical Society (formerly Bulletin de la Societe Belge de Physique) *(Belgium)*

Bull. Calcutta Math. Soc.
Bulletin of the Calcutta Mathematical Society *(India)*

Bull. Dir. Etud. Rech.
Bulletin de la Direction des Etudes et Recherches *(France)*

Bull. Earthquake Res. Inst., Univ. Tokyo
Bulletin of the Earthquake Research Inst., University of Tokyo
see ***Tokyo Daigaku Jishin Kenkyusho Iho***

Bull. Eidgenoess. Gesundh., Beil. B
Bulletin des Eidgenoessisches Gesundheitsamtes, Beilage B *(Switzerland)*

Bull. Entomol. Res.
Bulletin of Entomological Research *(England)*

Bull. Fac. Eng., Hiroshima Univ.
Bulletin of the Faculty of Engineering, Hiroshima University
see ***Hiroshima Daigaku Kogakubu Kenkyu Hokoku***

Bull. Fac. Sci. Eng., Chuo Univ.
Bulletin of the Faculty of Science and Engineering, Chuo University
see ***Chuo Daigaku Rikogakubu Kiyo***

Bull. Geophys. Observ., Haile Sellassie I Univ.
Bulletin of the Geophysical Observatory, Haile Sellassie I University *(Ethopia)*

Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl.
*Bulletin d'Information A.T.E.N. (Association Technique pour l'Energie Nucleaire), Supplement *(France)*

Bull. Inst. Geophys., Nat. Cent. Univ.
*Bulletin of the Institute of Geophysics, National Central University *(China (Taiwan))*

Bull. Inst. Int. Froid, Annexe
Bulletin de l'Institut International du Froid, Annexe *(France)*

Bull. Inst. Nat. Sante Rech. Med.
Bulletin de l'Institut National de la Sante et de la Recherche Medicale *(France)*

Bull. Instrum. Nucl.
*Bulletin Instrumentation Nucleaire (formerly Instrumentation Nucleaire) Supplement au Bulletin d'Informations Scientifiques et Techniques *(France)*

Bull. Inst. Space Aeronaut. Sci., Univ. Tokyo
Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo
see ***Tokyo Daigaku Uchu Koku Kenkyusho Hokoku***

Bull Int. Inst. Refrig., Suppl.
Bulletin of the International Institute of Refrigeration, Supplement
see ***Bull. Inst. Int. Froid, Annexe***

Bull. Kyoto Educ. Univ., Ser. B
Bulletin of the Kyoto Educational University, Series B. Mathematics and Natural Science *(Japan)*

Bull. Office Int. Epizoot.
Bulletin de l'Office International des Epizooties *(France)*

Bull. Res. Inst. Miner. Dressing Met., Tohoku Univ.
Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University
see ***Tohoku Daigaku Senko Seiren Kenkyusho Iho***

Bull. Soc. Roy. Bot. Belg.
Bulletin de la Societe Royale de Botanique de Belgique *(Belgium)*

Bull. Soc. Sea Water Sci., Jap.
Bulletin of the Society of Sea Water Science, Japan
see ***Nippon Kaisui Gakkaishi***

Bull. Tulane Univ. Med. Fac.

Bulletin of the Tulane University Medical Faculty *(U.S.)*
Bull. Volcanol.
Bulletin Volcanologique *(Italy)*
Bul. Stiint. Teh. Inst. Politeh. Timisoara
Buletinul Stiintific si Tehnic al Institutului Politehnic Timisoara *(Romania)*
Bus. Rev., Univ. Wash.
Business Review, University of Washington *(U. S.)*
Bus. Syst. Equip.
Business Systems and Equipment *(England)*
Bus. Week
Business Week *(U. S.)*
Byggmesteren
Byggmesteren (Norges Byggforskningsinstitutt) *(Norway)*
Byull. Inst. Teor. Astron.
Byulleten Instituta Teoreticheskoi Astronomii *(U.S.S.R.)*
Byull. Kom. Opred. Absol. Geol. Form.
Byulleten Komissii po Opredeleniyu Absolyutnogo Vozrasta Geologicheskikh Formatsii *(U.S.S.R.)*
CA—Cancer J. Clin.
CA— Cancer Journal Clinicians *(U.S.)*
Cah. Ing. Agron.
Cahiers des Ingenieurs Agronomes *(France)*
Cah. Oceanogr.
Cahiers Oceanographiques *(France)*
Calcified Tissue Res.
Calcified Tissue Research *(West Germany)*
Can. J. Ophthalmol.
Canadian Journal of Ophthalmology *(Canada)*
Can. J. Psychol.
Canadian Journal of Psychology *(Canada)*
Can. Mach. Metalwork.
Canadian Machinery and Metalworking *(Canada)*
Canner/Packer
Canner/Packer *(U. S.)*
Can. Nurse
Canadian Nurse *(Canada)*
Celul. Hirtie
*Celuluza si Hirtie *(Romania)*
Cercet. Met.
Cercetari Metalurgice *(Romania)*
Chartered Mech. Eng.
Chartered Mechanical Engineer *(England)*
Chem. Instrum.
*Chemical Instrumentation *(U. S.)*
Chem. Process. (London)
Chemical Processing (London) *(England)*
Chesapeake Sci.
Chesapeake Science *(U. S.)*
Chim. Ind., Genie Chim.
Chimie et Industrie, Genie Chimique (formed by the merger of Chimie et Industrie (Paris) and Genie Chimique (Paris)) *(France)*
Chin. Anim. Husb. Vet. Med.
Chinese Animal Husbandry and Veterinary Medicine
see **Chung Kuo Hsu Mu Shou I**
Chin. J. Dermatol.
Chinese Journal of Dermatology
see **Chung Hua P'i Fu K'o Tsa Chih**
Chin. J. Gynecol. Obstet.
Chinese Journal of Gynecology and Obstetrics
see **Chung Hua Fu Ch'an K'o Tsa Chih**
Chin. J. Phys. (Peking) (Engl. Transl.)
*Chinese Journal of Physics (Peking) (English Translation of Acta Physica Sinica (Wu Li Hsueh Pao)) *(U. S.)*
Chin. J. Surg.
Chinese Journal of Surgery
see **Chung Hua Wai K'o Tsa Chih**
Chromatographia
Chromatographia *(West Germany)*
Chung Hua Fu Ch'an K'o Tsa Chih
Chung Hua Fu Ch'an K'o Tsa Chih (Chinese Journal of Gynecology and Obstetrics) *(China)*
Chung Hua I Hsueh Tsa Chih
Chung Hua I Hsueh Tsa Chih (National Medical Journal of China) *(China)*
Chung Hua P'i Fu K'o Tsa Chih
Chung Hua P'i Fu K'o Tsa Chih (Chinese Journal of Dermatology) *(China)*
Chung Hua Wai K'o Tsa Chih
Chung Hua Wai K'o Tsa Chih (Chinese Journal of Surgery) *(China)*
Chung Kuo Hsu Mu Shou I
Chung Kuo Hsu Mu Shou I (Chinese Animal Husbandry and Veterinary Medicine) *(China)*
Chuo Daigaku Rikogakubu Kiyo
Chuo Daigaku Rikogakubu Kiyo (Bulletin of the Faculty of Science and Engineering, Chuo University) *(Japan)*
Civil Eng. (N. Y.)
Civil Engineering (New York) *(U. S.)*
Clay Sci. (Tokyo)
Clay Science (Tokyo) *(Japan)*
Coal Age
Coal Age *(U. S.)*
Cobalt
Cobalt *(France)*
Colloid J. (USSR) (Engl. Transl.)
Colloid Journal (USSR) (English Translation of Kolloidnyi Zhurnal) *(U. S.)*
Colloq. Int. Cent. Nat. Rech. Sci.
Colloques Internationaux du Centre National de la Recherche Scientifique *(France)*
Combustion
Combustion *(U.S.)*
Commer. Fish. Rev.
Commercial Fisheries Review *(U. S.)*
Commun. Math. Phys.
Communications in Mathematical Physics *(West Germany)*
Compt. Rend. Soc. Geol. Fr.
Compte Rendu Sommaire des Seances de la Societe Geologique de France *(France)*
Comput. Biomed. Res.
Computers and Biomedical Research *(U. S.)*
Concrete J.
Concrete Journal
see **Konkurito Jaaru**
Constr. Mesini
Constructia de Masini *(Romania)*
Coord. Chem. Rev.
Coordination Chemistry Reviews *(Netherlands)*
Corros. Prev. Contr.
Corrosion Prevention and Control *(England)*
Cuivre, Laitons, Alliages
Cuivre, Laitons, Alliages *(France)*
Curr. Awareness Bull.
Current Awareness Bulletin *(U. S.)*
Curr. Mod. Biol.
Currents in Modern Biology *(Netherlands)*
Czas. Stomatol.
Czasopismo Stomatologiczne *(Poland)*
Dan. Med. Bull.
Danish Medical Bulletin *(Denmark)*
Denki Shikenjo Kenkyu Hokoku
Denki Shikenjo Kenkyu Hokoku (Researches of the Electrotechnical Laboratory) *(Japan)*
Desalination
Desalination *(Netherlands)*
Des. Components Eng.
Design and Components in Engineering *(England)*
Deut. Hydrogr. Z.
Deutsche Hydrographische Zeitschrift *(West Germany)*
Deut. Zahn-, Mund- Kieferheilk.
Deutsche Zahn-, Mund- und Kieferheilkunde mit Zentralblatt fuer die Gesamte Zahn-, Mund- und Kieferheilkunde *(East Germany)*
Deut. Z. Gesam. Gerichtl. Med.
Deutsche Zeitschrift fuer die Gesamte Gerichtliche Medizin *(West Germany—U. S.)*
Diffus. Data
*Diffusion Data *(U. S.)*
DMIC Rev.
DMIC Review of Recent Developments *(U. S.)*
Doboku Gijutsu
Doboku Gijutsu (Civil Engineering) *(Japan)*
Doc-Air-Espace
*Doc-Air-Espace *(France)*
Dokl.—Bot. Sci. Sect. (Engl. Transl.)
Doklady—Botanical Sciences Sections (English Translation) *(U.S.)*
Drevo
Drevo *(Czechoslovakia)*
Earth-Sci. Rev.
Earth-Science Reviews *(Netherlands)*
Eiyo To Shokuryo
Eiyo To Shokuryo (Journal of Japanese Society of Food and Nutrition) *(Japan)*
Ekon. Samf. Tidskr.
Ekonomiska Samfundets Tidskrift *(Sweden)*
Electron. Equip. News
Electronic Equipment News *(England)*
Electron. Ind. (Paris).
Electronique Industrielle (Paris) *(France)*

Electron. Packag. Prod.
Electronic Packaging and Production *(U. S.)*
Electrotechniek
Electrotechniek *(Netherlands)*
Elec. World
Electrical World *(U. S.)*
Elec. World (Shanghai)
Electrical World (Shanghai)
see Tien Shih Chieh
Elektrizitaetsverwertung
Elektrizitaetsverwertung *(Switzerland)*
Elektromedizin
Elektromedizin und Ihre Grenzgebiete *(Germany)*
Elektron. Bol'shikh Moshch.
Elektronika Bol'shikh Moshchnostei *(U.S.S.R.)*
Elektron. Obrab. Mater.
Elektronnaya Obrabotka Materialov *(Moldavian S.S.R.)*
Elektron. Rechenanlagen
Elektronische Rechenanlagen *(West Germany)*
Elektrotech. Cas.
Elektrotechnicky Casopis *(Czechoslovakia)*
Elektrotekhnika
Elektrotekhnika *(U.S.S.R.)*
Elektr. Sta.
Elektricheskie Stantsii *(U.S.S.R.)*
Engei Gakkai Zasshi
Engei Gakkai Zasshi (Journal of the Japanese Society for Horticultural Science) *(Japan)*
Engl. Elec. J.
English Electric Journal *(England)*
Entropie
Entropie *(France)*
Environ. Res.
Environmental Research *(U. S.)*
EPE, Rev. Energ. Primaire
EPE, Revue Energie Primaire
see Rev. Energ. Primaire
Ergonomics
Ergonomics *(England)*
Euratom Rev.
*Euratom Review of the European Atomic Energy Community (formerly Euratom Bulletin) *(Belgium)*
Exp. Pathol.
Experimentelle Pathologie *(East Germany)*
Farm, Ranch, Home Quart.
Farm, Ranch and Home Quarterly *(U. S.)*
FDA (Food Drug Admin.) Pap.
FDA (Food and Drug Administration) Papers *(U. S.)*
Fiz. Chastits Vys. Energ., Akad. Nauk Gruz. SSSR, Inst. Fiz.
Fizika Chastits Vysokikh Energii, Akademiya Nauk Gruzinskoi SSR, Institut Fiziki *(Georgian S.S.R.)*
Fiziol. Norm. Patol. (Bucharest)
Fiziologia Normala si Patologica (Bucharest) *(Romania)*
Fiz. Khim. Obrab. Mater.
Fizika i Khimiya Obrabotki Materialov *(U.S.S.R.)*
Fiz. Tekh. Poluprov.
*Fizika i Tekhnika Poluprovodnikov *(U.S.S.R.)*
Flame Notes, Beckman
Flame Notes, Beckman *(U. S.)*
Flug-Rev. Int.
Flug-Revue International *(West Germany)*
FOA (Forsvarets Forsk.) Rep.
*FOA (Forsvarets Forskningsanstalt) Reports *(Sweden)*
Folia Haematol. (Leipzig)
Folia Haematologia (Leipzig) *(East Germany)*
Folia Med. Cracov.
Folia Medica Cracoviensia *(Poland)*
Food Eng. (Philadelphia)
Food Engineering (Philadelphia) (formerly Food Industries) *(U. S.)*
Forest. Abstr.
Forestry Abstracts *(England)*
Forsch. Ingenieurw.
Forschung im Ingenieurwesen *(West Germany)*
Fortschr. Hochpolym.-Forsch.
Fortschritte der Hochpolymeren-Forschung *(West Germany)*
Fortschr. Zool.
Fortschritte de Zoologie *(West Germany)*
Foundry
Foundry *(U. S.)*
Freiberg. Forschungsh., B
Freiberger Forschungshefte, Reihe B *(East Germany)*
Fukuoka Acta Med.
Fukuoka Acta Medica
see Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi (Fukuoka Acta Medica) *(Japan)*
Fukushima Daigaku Gakugei Gakubu Rika Hokoku
Fukushima Daigaku Gakugei Gakubu Rika Hokoku (The Science Reports of the Faculty of Arts and Science, Fukushima University) *(Japan)*
Genet. Pol.
*Genetica Polonica *(Poland)*
Geofiz. App.
Geofizicheskaya Apparatura *(U.S.S.R.)*
Geofiz. Byull.
Geofizicheskii Byulleten *(U.S.S.R.)*
Geofys. Sb.
Geofysikalni Sbornik *(Czechoslovakia)*
Geol. Geofiz.
Geologiya i Geofizika *(U.S.S.R.)*
Geol. Nefti Gaza
Geologiya Nefti i Gaza† *(U.S.S.R.)*
Geol. Soc. Amer., Spec. Pap.
Geological Society of America, Special Paper *(U. S.)*
Geophys. Geol. (Leipzig)
Geophysik und Geologie (Leipzig) *(East Germany)*
Gidrodinamekhanika
Gidrodinamekhanika *(Ukrainian S.S.R.)*
Giesserei
Giesserei *(West Germany)*
G-I-T (Glas- Instrum.-Tech.) Fachz. Lab.
G-I-T (Glas- und Instrumenten-Technik) Fachzietschrift fuer das Laboratorium *(West Germany)*
Glas-Instrum.-Tech.
Glas-Instrumenten-Technik *(West Germany)*
Glass Ceram. (USSR) (Engl. Transl.)
Glass and Ceramics (USSR) (English Translation of Stekio i Keramika) *(U. S.)*
Gorn. Zh.
Gornyi Zhurnal *(U.S.S.R.)*
Grinding Finish.
Grinding and Finishing *(U. S.)*
Haematologia (Budapest)
Haematologia (Budapest) *(Hungary)*
Haikan Gijutsu
Haikan Gijutsu (The Piping Engineering) *(Japan)*
Handb. Med. Radiol.
Handbuch der Medizinschen Radiologie *(West Germany)*
Harper Hosp. Bull.
Harper Hospital Bulletin *(U. S.)*
Health Lab. Sci.
Health Laboratory Science *(U. S.)*
Heidelberg. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber.
Heidelberger Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Klasse, Sitzungsberichte *(West Germany)*
Hemel Dampkring
Hemel en Dampkring *(Belgium)*
Hiroshima Daigaku Kogakubu Kenkyu Hokoku
Hiroshima Daigaku Kogakubu Kenkyu Hokoku (Bulletin of the Faculty of Engineering, Hiroshima University) *(Japan)*
Hoken Butsuri
Hoken Butsuri (Journal of Japan Health Physics Society) *(Japan)*
Hokkaidoritsu Eisei Kenkyushoho
Hokkaidoritsu Eisei Kenkyushoho (Report of the Hokkaido Inst. of Public Health) *(Japan)*
Hokuno
Hokuno (Agriculture in Hokkaido) *(Japan)*
Honvedorvos
Honvedorvos *(Hungary)*
Hyg. Sanit. (USSR) (Engl. Transl.)
Hygiene and Sanitation (USSR) (English Translation of Gigiena i Sanitariya) *(U. S.)*
Hyogo Noka Daigaku Kiyo
Hyogo Noka Daigaku Kiyo (Memoirs of the Hyogo University of Agriculture) *(Japan)*
Idengaku Zasshi, Suppl.
Idengaku Zasshi, Supplement (Japanese Journal of Genetics, Supplement) *(Japan)*
IEEE (Inst. Elec. Electron. Eng.) Trans. Audio Electroacoust.
*IEEE (Institute of Electrical and Electronics Engineers) Transactions on Audio and Electroacoustics *(U.S.)*
Ig. Sanita Pubblica
Igiene e Sanita Pubblica *(Italy)*
Ind.-Anz.
Industrie-Anzeiger *(West Germany)*
Ind.-Elektron. Forsch. Fertigung
Industrie-Elektronik in Forschung und Fertigung *(West Germany)*
Indian J. Agr. Sci.

Indian Journal of Agricultural Science, The *(India)*
Indian J. Appl. Chem.
Indian Journal of Applied Chemistry *(India)*
Indian J. Cancer
Indian Journal of Cancer *(India)*
Indian J. Occup. Health
Indian Journal of Occupational Health *(India)*
Indian Pediat.
Indian Pediatrics *(India)*
Ind. Minerarla
Industria Mineraria *(Italy)*
Ind. Process Heat.
Industrial and Process Heating *(England)*
Ind. Water Eng.
Industrial Water Engineering *(U. S.)*
Inform. Byull. Sov. Antarkt. Eksped.
Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*
Ing. Bygningsv., Ugeovers.
Ingenieor- og Bygningsvaesen, Ugeoversigt *(Denmark)*
Inst. Mining Met., Trans./Sect. B
Institution of Mining and Metallurgy, Transactions/Section B. Applied Earth Science (continues in part Transactions of the Institution of Mining and Metallurgy) *(England)*
Inst. Petrol. Rev.
Institute of Petroleum Review, The *(England)*
Instrum. Contr. Eng.
Instrument and Control Engineering *(England)*
Instrum. Med.
Instrumentation in Medicine *(England)*
Int. Ass. Sci. Hydrol., Bull.
International Association of Scientific Hydrology, Bulletin *(Belgium)*
Int. Chem. Eng.
*International Chemical Engineering. A Quarterly Journal of Translations from Russia, Eastern Europe, and Asia *(U. S.)*
Int. Dig. Health Legislation
International Digest of Health Legislation *(Switzerland)*
Int. J. Mass Spectrom. Ion Phys.
International Journal of Mass Spectrometry and Ion Physics
see J. Mass Spectrom. Ion Phys.
Int. J. Neurol.
International Journal of Neurology *(U. S.)*
Int. Rev. Gesam. Hydrobiol.
Internationale Revue der Gesamten Hydrobiologie *(East Germany)*
Int. Surg.
International Surgery *(U. S.)*
Inzh. Zh., Mekh. Tverd. Tela
Inzhenernyi Zhurnal, Mekhanika Tverdogo Tela (formerly Inzhenernyi Zhurnal) *(U.S.S.R.)*
Iron Age Metalwork. Int.
Iron Age Metalworking International *(U. S.)*
ISA (Instrum. Soc. Amer.), Proc., Nat. Power Instrum. Symp.
ISA (Instrument Society of America), Proceedings, National Power Instrumentation Symposium *(U. S.)*
Issled. Genet.
Issledovaniya po Genetike *(U.S.S.R.)*
Issled. Primen. Tsifrovykh Analogovykh Vychisl. Mash. Yed. Fiz. Tekh., Sb. Statei (U.S.S.R.)
*Issledovanie Primenenii Tsifrovykh i Analogovykh Vychislitel'nykh Mashin v Yadernoi Fizike i Tekhnike, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Statei *(U.S.S.R.)*
Izobret., Prom. Obraztsy, Tovarnye Znaki
Izobreteniya, Promyshlennye Obraztsy, Tovarnye Znaki *(U.S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Biol. Nauki
Izvestiya Akademii Nauk Armyanskoi SSR, Biologicheskie Nauki (superseded by Biologicheskii Zhurnal Armenii) *(Armenian S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Ser. Fiz.-Mat. Nauk
Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Armenian S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Ser. Tekh. Nauk
Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Tekhnicheskikh Nauk *(Armenian S.S.R.)*
Izv. Akad. Nauk Kaz. SSR, Ser. Khim.
Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Khimicheskaya *(Kazakh S.S.R.)*
Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk, Mekh. Mashinostr.
Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Mekhanika i Mashinostroenie *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Ser. Biol.
Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Ser. Geol.
Izvestiya Akademii Nauk SSSR, Seriya Geologicheskaya *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Ser. Mat.
Izvestiya Akademii Nauk SSSR, Seriya Matematicheskaya *(U.S.S.R.)*
Izv. Akad. Nauk Tadzh. SSR, Otd. Fiz.-Tekh. Khim. Nauk
Izvestiya Akademii Nauk Tadzhikskoi SSR, Otdelenie Fiziko-Tekhnicheskikh i Khimicheskikh Nauk *(Tadzhik S.S.R.)*
Izv. Inst. Elektron., Bulg. Akad. Nauk.
Izvestiya na Instituta po Elektronika, Bulgarska Akademiya na Naukite *(Bulgaria)*
Izv. Inst. Khidrol. Meteorol., Bulg. Akad. Nauk.
Izvestiya na Institutapo Khidrologiya i Meteorologiya, Bulgarska Akademiya na Naukite, Otdelenie za Matematicheski i Fizicheski Nauki *(Bulgaria)*
Izv. Vost. Filial. Akad. Nauk SSSR
Izvestiya Vostochniykh Filialov Akademii Nauk SSSR *(U.S.S.R.)*
Izv. Vyssh. Ucheb. Zaved., Mat.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Matematika *(U.S.S.R.)*
Izv. Vyssh. Ucheb. Zaved., Priborostr.
Izvestiya Vysshikh Uchebnykh Zavedenii, Priborostroenie *(U.S.S.R.)*
Izv. Vyssh. Ucheb. Zaved., Tekhnol. Legk. Prom.
Izvestiya Vysshikh Uchebnykh Zavedenii, Tekhnologiya Legkoi Promyshlennosti *(Ukrainian S.S.R.)*
J. Amer. Podiat. Ass.
Journal of the American Podiatry Association *(U. S.)*
Jap. J. Dairy Sci.
Japanese Journal of Dairy Science (Japan)
see Rakuno Kagaku no Kenkyu
Jap. J. Exp. Morphol.
Japanese Journal of Experimental Morphology
see Jikken Kotaigakushi
Jap. J. Genet., Suppl.
Japanese Journal of Genetics, Supplement
see Idengaku Zasshi, Suppl.
Jap. J. Pharm. Chem.
Japanese Journal of Pharmacy and Chemistry
see Yakugaku Kenkyu
Jap. J. Zootech. Sci.
Japanese Journal of Zootechnical Science
see Nippon Chikusangaku Kaiho
JARE Sci. Rep., Spec. Issue
JARE Scientific Reports, Special Issue *(Japan)*
J. Ass. Phys. Ment. Rehabil.
Journal of the Association for Physical and Mental Rehabilitation *(U. S.)*
J. Aust. Ceram. Soc.
Journal of the Australian Ceramic Society *(Australia)*
J. Balneol. Soc. Jap.
Journal of the Balneological Society of Japan
see Onsen Kagaku
J. Belge Radiol., Monogr.
*Journal Belge de Radiologie, Monographie *(Belgium)*
J. Biol. Photogr. Ass.
Journal of the Biological Photographic Association, The *(U. S.)*
J. Brit. Ceram. Soc.
Journal of the British Ceramic Society, The *(England)*
J. Cell Sci.
*Journal of Cell Science *(England)*
J. Cons. Perma. Int. Explor. Mer
Journal du Conseil, Conseil Permanent International pour l'Exploration de la Mer *(Denmark)*
J. Cryst. Growth
Journal of Crystal Growth *(Netherlands)*
J. Egypt. Public Health Ass.
Journal of the Egyptian Public Health Association *(Egypt)*
Jemna Mech. Opt.
Jemna Mechanika a Optika *(Czechoslovakia)*
Jeune Sci.
Jeune Scientifique *(Canada)*
J. Food Sci. Technol.
Journal of Food Science and Technology
see Nippon Shokuhin Kogyo Gakkaishi
J. Forensic Med.
Journal of Forensic Medicine *(South Africa)*
J. Formosan Med. Ass.
Journal of the Formosan Medical Association
see T'ai-wan I Hsueh Hui Tsa Chih
J. Fuel Heat. Technol.
Journal of Fuel and Heating Technology *(England)*
J. Geol.

Journal of Geology *(U. S.)*

J. High Polym. (Shanghai)
Journal of High Polymers (Shanghai)
see ***Kao Fen Tzu T'ung Hsun***

Jibiinkoka Rinsho
Jibiinkoka Rinsho (Oto-Rhino-Laryngological Clinic) *(Japan)*

Jikken Keitaigakushi
Jikken Keitaigakushi (Japanese Journal of Experimental Morphology) *(Japan)*

J. Indian Soc. Soil Sci.
Journal of the Indian Society of Soil Science *(India)*

J. Inst. Safety High Pressure Gas Eng.
Journal of the Inst. of Safety of High Pressure Gas Engineering
see ***Koatsu Gasu***

J. Inst. Telecommun. Eng.
Journal of the Institution of Telecommunication Engineers *(India)*

J. Irrig. Drain. Div., Amer. Soc. Civil Eng.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers *(U. S.)*

J. Jap. Health Phys. Soc.
Journal of Japan Health Physics Society
see ***Hoken Butsuri***

J. Jap. Med. Ass.
Journal of the Japan Medical Association, The
see ***Nippon Ishikai Zasshi***

J. Jap. Petrol. Inst.
Journal of the Japan Petroleum Institute
see ***Sekiyu Gakkaishi***

J. Jap. Soc. Food Nutr.
Journal of Japanese Society of Food and Nutrition
see ***Eiyo To Shokuryo***

J. Jap. Soc. Hort. Sci.
Journal of the Japanese Society for Horticultural Science
see ***Engei Gakkai Zasshi***

J. Jap. Stomatol. Soc.
Journal of the Japan Stomatological Society, The
see ***Kokubyo Gakkai Zasshi***

J. Jap. Tech. Ass. Pulp Pap. Ind.
Journal of the Japanese Technical Association of Pulp and Paper Industry
see Kami Pa Gikyoshi

J. Jap. Wood Res. Soc.
Journal of the Japan Wood Research Society
see ***Mokuzai Gakkaishi***

J. Karnatak Univ.
Journal of the Karnatak University *(India)*

J. Macromol. Sci., Part A
Journal of Macromolecular Science, Part A. Chemistry (supersedes Journal of Macromolecular Chemistry) *(U. S.)*

J. Marine Res.
Journal of Marine Research (Sears Foundation for Marine Research) *(U.S.)*

J. Mass Spectrom. Ion Phys.
*Journal of Mass Spectrometry and Ion Physics *(Netherlands)*

J. Metal Finish. Soc. Jap.
Journal of the Metal Finishing Society of Japan, The
see ***Kinzoku Hyomen Gijutsu***

J. Mol. Struct.
*Journal of Molecular Structure *(Netherlands)*

J. Nagasaki Med. Ass., Suppl.
Journal of the Nagasaki Medical Association, Supplement
see ***Nagasaki Igakkai Zasshi, Suppl.***

J. Nucl. Med., Suppl.
*Journal of Nuclear Medicine, Supplement *(U.S.)*

J. Nucl. Sci. (Seoul)
*Journal of Nuclear Sciences (Seoul) (Wonjaryogwon. Yon'gu Nonmun Chip) *(South Korea)*

J. Optimization Theory Appl.
Journal of Optimization Theory and Applications *(U. S.)*

J. Osaka Univ. Dent. Soc.
Journal of the Osaka University Dental Society, The
see ***Osaka Daigaku Shigaku Zasshi***

J. Otolaryngol. Soc. Aust.
Journal of the Otolaryngological Society of Australia *(Australia)*

J. Paleontol.
Journal of Paleontology *(U.S.)*

J. Phys., A (London)
*Journal of Physics, A (London), Proceedings of the Physical Society (General) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., B (London)
*Journal of Physics, B (London), Proceedings of the Physical Society (Atomic and Molecular Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., C (London)
*Journal of Physics, C (London), Proceedings of the Physical Society (Solid State Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., E (London)
*Journal of Physics, E (London) (supersedes Journal of Scientific Instruments) *(England)*

J. Phys. Chem. Solids, Suppl.
*Journal of Physics and Chemistry of Solids, Supplement *(England)*

J. Phys. Soc. Jap., Suppl.
*Journal of the Physical Society of Japan, Supplement *(Japan)*

J. Radioanal. Chem.
*Journal of Radioanalytical Chemistry *(Netherlands–Hungary)*

J. Radiol. Phys. Ther., Univ. Kanazawa
Journal of Radiology and Physical Therapy, University of Kanazawa, The
see ***Kanazawa Irigaku Sosho***

J. Roy. Army Med. Corps
Journal of the Royal Army Medical Corps *(England)*

J. Sediment. Petrol.
Journal of Sedimentary Petrology *(U. S.)*

J. Soc. Eng. Miner. Springs, Jap.
Journal of the Society of Engineers for Mineral Springs, Japan
see ***Onsen Kogakkaishi***

J. Soc. Fiber Sci. Technol., Jap.
Journal of the Society of Fiber Science and Technology, Japan
see ***Sen'i Gakkaishi***

J. Soc. Instrum. Contr. Eng.
Journal of the Society of Instrument and Control Engineers
see ***Keisoku To Seigyo***

J. Soc. Leather Trades Chem.
Journal of the Society of Leather Trades Chemists *(England)*

J. Soc. Rubber Ind., Jap.
Journal of the Society of Rubber Industry, Japan
see ***Nippon Gomu Kyokaishi***

J. Tokyo Women's Med. Coll.
Journal of Tokyo Women's Medical College
see ***Tokyo Joshi Ika Daigaku Zasshi***

Jugoslov. Pronalazastvo
Jugoslovensko Pronalazastvo *(Yugoslavia)*

Kagaku Keisatsu Kenkyusho Hokoku
Kagaku Keisatsu Kenkyusho Hokoku (Reports of the National Research Inst. of Police Science) *(Japan)*

Kagoshima Daigaku Suisangakubu Kiyo
Kagoshima Daigaku Suisangakubu Kiyo (Memoirs of the Faculty of Fisheries, Kagoshima University) *(Japan)*

Kaibogaku Zasshi
Kaibogaku Zasshi (Acta Anatomica Nipponica) *(Japan)*

Kali Steinsalz
Kali und Steinsalz *(West Germany)*

Kami Pa Gikyoshi
Kami Pa Gikyoshi (Journal of the Japanese Technical Association of Pulp and Paper Industry) *(Japan)*

Kanazawa Irigaku Sosho
Kanazawa Irigaku Sosho (Journal of Radiology and Physical Therapy, University of Kanazawa, The) *(Japan)*

Kao Fen Tzu T'ung Hsun
Kao Fen Tzu T'ung Hsun (Journal of High Polymers) *(China)*

Keisoku To Seigyo
Keisoku To Seigyo (Journal of the Society of Instrument and Control Engineers) *(Japan)*

Kenchiku Gijutsu
Kenchiku Gijutsu (Building Engineering) *(Japan)*

Kernenergie, Beil.
*Kernenergie, Beilage *(East Germany)*

Kinzoku Hyomen Gijutsu
Kinzoku Hyomen Gijutsu (The Journal of the Metal Finishing Society of Japan) *(Japan)*

Kleinhoubacher Ber.
Kleinhoubacher Berichte *(East Germany)*

Klin. Monatsbl. Augenheilk.
Klinische Monatsblaetter fuer Augenheilkunde und fuer Augenaerztliche Fortbildung *(West Germany)*

Koatsu Gasu
Koatsu Gasu (Journal of the Inst. of Safety of High Pressure Gas Engineering) *(Japan)*

Kobe Kogyo Giho
Kobe Kogyo Giho (Kobe Kogyo Technical Report) *(Japan)*

Kobe Kogyo Tech. Rep.
Kobe Kogyo Technical Report
see ***Kobe Kogyo Giho***

K'o Hsueh Tu Chung
K'o Hsueh Tu Chung (Popular Science) *(China)*

Kokubyo Gakkai Zasshi
Kokubyo Gakkai Zasshi (Journal of the Japan Stomatological Society, The) *(Japan)*
Kenkurito Jenaru
Konkurito Janaru (Concrete Journal) *(Japan)*
Konserv. Ovoshchesush. Prom.
Konservnaya i Ovoshchesushil'naya Promyshlennost *(U.S.S.R.)*
Korroz. Metal. Splavov
Korroziya Metallov i Splavo *(U.S.S.R.)*
Kosm. Biol. Med.
Kosmicheskaya Biologiya i Meditsina *(U.S.S.R.)*
Kosm. Luchi
Kosmicheskie Luchi *(U.S.S.R.)*
Kovove Mater.
Kovove Materialy *(Czechoslovakia)*
Kowan Giken Shiryo
Kowan Giken Shiryo (Technical Note of Port and Harbour Technical Research Inst., Ministry of Transportation, Japan) *(Japan)*
Krist. Tech.
Kristall und Technik *(East Germany)*
Kuki Seijo
Kuki Seijo (Air Cleaning) *(Japan)*
Kumamoto Daigaku Kogakubu Kenkyu Hokoku
Kumamoto Daigaku Kogakubu Kenkyu Hokoku (Technical Reports of the Kumamoto University) *(Japan)*
Kumamoto Daigaku Kyoikugakubu Kiyo
Kumamoto Daigaku Kyoikugakubu Kiyo (Memoirs of the Faculty of Education, Kumamoto University) *(Japan)*
Kurznachr. Akad. Wiss. Goettingen
Kurznachrichten der Akademie der Wissenschaften in Goettingen *(West Germany)*
Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku
Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku (Report of the Training Inst. for Engineering Teachers, Kyoto University) *(Japan)*
Kyushu Daigaku Kogaku Shuho
Kyushu Daigaku Kogaku Shuho (Technology Reports of the Kyushu University) *(Japan)*
Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku
Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku (The Reports of the Research Inst. of Science and Industry, Kyushu University) *(Japan)*
Lakokrasoch. Mater. Ikh Primen.
Lakokrasochnye Materialy i Ikh Primenenie *(U.S.S.R.)*
Landbouwtijdschrift
Landbouwtijdschrift *(Belgium)*
Lasers Opt. Non Conv.
Lasers et Optique Non Conventionelle *(France)*
Lebensversicherungsmedizin
Lebensversicherungsmedizin *(West Germany)*
Light Metals
Light Metals (superseded by Light Metals and Metals Industry (London)) *(England)*
Light Metals Metal Ind. (London)
*Light Metals and Metal Industry (London) (formed by merger of Light Metals and The Metal Industry (London)) *(England)*
Lipids
Lipids *(U. S.)*
Liteinoe Proizvod.
Liteinoe Proizvodstvo *(U.S.S.R.)*
Lithos
Lithos *(Norway)*
Lutte Cancer
Lutte Contre le Cancer *(France)*
Machinery (N. Y.)
Machinery (New York) *(U. S.)*
Mech. Prod. Eng.
Machinery and Production Engineering *(England)*
Mech. Shop Eng. Mfg.
Machine Shop and Engineering Manufacture *(England)*
Mech. Tool Blue Book
Machine and Tool Blue Book *(U. S.)*
Mag. Stand.
Magazine of Standards *(U. S.)*
Magy. Traumatol., Orthop. Helyreallito Sebesz.
Magyar Traumatologia, Orthopaedia es Helyreallito Sebeszet *(Hungary)*
Manage. Sci.
Management Science *(U.S.)*
Mashinovedenie
Mashinovedenie *(U.S.S.R.)*
Mass Prod.
Mass Production *(England)*
Mater. Res. Bull.
Materials Research Bulletin *(U. S.)*
Mech. World Eng. Rec.
*Mechanical World and Engineering Record *(England)*
Med. Bull. U. S. Army, Eur.
Medical Bulletin of the U. S. Army, Europe *(U.S.)*
Mededel. Kon. Vlaam. Acad. Wetensch. Belg., Kl. Wetensch.
Mededelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van Belgie, Klasse der Wetenschappen *(Belgium)*
Med. Nucl.-Radiobiol. Lat., Suppl.
*Medicina Nucleare—Radiobiologica Latina, Suppl. *(Italy)*
Med. Radiol. (USSR) (Engl. Transl.)
Medical Radiology (USSR) (English Translation of Meditsinskaya Radiologiya) *(U. S.)*
Mekh. Elek. Sots. Sel. Khoz.
Mekhanizatsiya i Elektrifikatsiya Sotsialisticheskogo Sel'skogo Khozyaistva *(U.S.S.R.)*
Mekh. Polim.
Mekhanika Polimerov *(Latvian S.S.R.)*
Mekh. Razrusheniya Metal., Akad. Nauk Ukr. SSR, Respub. Mezhvedom. Sb.
Mekhanizm Razrusheniya Metallov, Akademiya Nauk Ukrainskoi SSR, Respublikanskii Mezhvedomstvennyi Sbornik *(Ukrainian S.S.R.)*
Mem. Fac. Educ., Kumamoto Univ.
Memoirs of the Faculty of Education, Kumamoto University
see **Kumamoto Daigaku Kyoikugakubu Kiyo**
Mem. Fac. Fish., Kagoshima Univ.
Memoirs of the Faculty of Fisheries, Kagoshima University
see **Kagoshima Daigaku Suisangakubu Kiyo**
Mem. Fac. Sci., Kyoto Univ., Ser. Biol.
Memoirs of the Faculty of Science, Kyoto University, Series of Biology (formerly Memoirs of the College of Science, University of Kyoto, Series B (Biology)) *(Japan)*
Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., Geophys., Chem.
Memoirs of the Faculty of Science, Kyoto University, Series of Physics, Astrophysics, Geophysics, and Chemistry (formerly Memoirs of the College of Science, University of Kyoto, Series A) *(Japan)*
Mem. Hyogo Univ. Agr.
Memoirs of the Hyogo University of Agriculture
see **Hyogo Noka Daigaku Kiyo**
Meres Automat.
Meres es Automatika *(Hungary)*
Mes., Regul., Automat.
Mesures, Regulation, Automatisme *(France)*
Messtechnik
*Messtechnik. Zeitschrift fuer Instrumentenkunde (supersedes Zeitschrift fuer Instrumentenkunde) *(West Germany)*
Metabolism
*Metabolism: Clinical and Experimental *(U. S.)*
Metal Finish.
Metal Finishing *(U. S.)*
Metallwirtschaft
Metallwirtschaft—Wissenschaft—Technik *(Germany)*
Metals (London)
Metals (London) *(England)*
Metals Abstr.
*Metals Abstracts (successor to Review of Metal Literature and Metallurgical Abstracts) *(U. S.-England)*
Metal Sci. Heat Treat. (USSR) (Engl. Transl.)
Metal Science and Heat Treatment (USSR) (English Translation of Metallovedenie i Termicheskaya Obrabotka Metallov) *(U. S.)*
Metal Treat.
Metal Treating *(U. S.)*
Met. Elec. (Madrid)
Metalurgia y Electricidad (Madrid) *(Spain)*
Meteoritika
Meteoritika *(U.S.S.R.)*
Method. Phys. Anal.
Methodes Physiques d'Analyse *(France)*
Met. Rev. (Publ. in Metals Mater.)
Metallurgical Reviews (Published in Metals and Materials) *(England)*
Met. Spec. (Paris)
Metallurgie Speciale (Paris) *(France)*
Microwaves
Microwaves *(U. S.)*
Mie Kaibo Gyosekishu
Mie Kaibo Gyosekishu *(Japan)*
Milk Dealer
Milk Dealer, The *(U. S.)*
Miner. Deposita
Mineralium Deposita *(West Germany)*

Minerva Med. Giuliana
*Minerva Medica Giuliana. Supplemento a Minerva Medica *(Italy)*

Minerva Med. Sicil.
*Minerva Medica Siciliana (continuation of Gazzetta Medica Siciliana) Supplemento a Minerva Medica *(Italy)*

Minerva Med., Suppl.
*Minerva Medica, Supplemento *(Italy)*

Minerva Radiol.
*Minerva Radiologica (formerly Minerva Radiologica, Fisioterapica e Radiobiologica) *(Italy)*

Mines Met.
Mines et Metallurgie *(France)*

Mining Congr. J.
Mining Congress Journal *(U. S.)*

Mining Met. Quart. (USSR) (Engl. Transl.)
Mining and Metallurgy Quarterly (USSR) (English Translation of Rudarsko-Metalurski Zbornik) *(Yugoslavia)*

Mining Met. Quart. (USSR) (Engl. Transl.), Suppl.
Mining and Metallurgy Quarterly, (USSR) (English Translation of Rudarsko-Metalurski Zbornik, Supplement) *(Yugoslavia)*

Mod. Packag.
Modern Packaging *(U. S.)*

Mod. Unfallverhuet.
Moderne Unfallverhuetung *(West Germany)*

Mokuzai Gakkaishi
Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) *(Japan)*

Mol. Biol.
*Molekulyarnaya Biologiya *(U.S.S.R.)*

Mon. Corresp. Beförd. Erd Himmelskunde
Monatliche Correspondenz zur Beförderung der Erd und Himmelskunde *(East Germany)*

Monit. Zool. Ital., Suppl.
Monitore Zoologico Italiano, Supplemento *(Italy)*

Monogr. Nucl. Med. Biol.
Monographs on Nuclear Medicine and Biology *(Netherlands)*

Montes
Montes *(Spain)*

Motor Ship
Motor Ship *(England)*

Motortech. Z.
Motortechnische Zeitschrift *(West Germany)*

Muanyag Gumi
Muanyag es Gumi *(Hungary)*

Nachrichtentechnik
Nachrichtentechnik *(East Germany)*

Nagano Kogyo Koto Senmon Gakko Kiyo
Nagano Kogyo Koto Senmon Gakko Kiyo (Research Reports, Nagano Technical College) *(Japan)*

Nagasaki Igakkai Zasshi, Suppl.
Nagasaki Igakkai Zasshi, Supplement (Journal of the Nagasaki Medical Association, Supplement) *(Japan)*

Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Universitatis Nankinensis Scientiarum Naturalium) *(China)*

Nat. Fire Codes
National Fire Codes *(U. S.)*

Nat. Med. J. China
National Medical Journal of China
see Chung Hua I Hsueh Tsa Chih

Nauch. Zap. Inst. Mashinoved. Avtomat., Akad. Nauk Ukr. SSR, Ser. Mashinoved.
Nauchnye Zapiski Instituta Mashinovedeniya i Avtomatiki, Akademiya Nauk Ukraninskoi SSR, Seriya Mashinovedeniya *(Ukrainian S.S.R.)*

Neftegazov. Geol. Geofiz.
Neftegazovaya Geologiya i Geofizika *(U.S.S.R.)*

Nerv. Syst., Leningrad. Gos. Univ., Fiziol. Inst.
Nervnaya Sistema, Leningradskii Gosudarstvennyi Universitet imeni A. A. Zhdanova, Fiziologicheskii Institut *(U.S.S.R.)*

Neth. J. Sea Res.
Netherlands Journal of Sea Research *(Netherlands)*

Neues Jahrb. Mineral., Monatsh.
Neues Jahrbuch fuer Mineralogie, Monatshefte *(West Germany)*

Newslett. Isotop. Generator Inform. Centre
*Newsletter of the Isotopic Generator Information Centre *(France)*

Nippon Byori Gakkai Kaishi
Nippon Byori Gakkai Kaishi (Transactiones Societatis Pathologicae Japonicae) *(Japan)*

Nippon Chikusangaku Kaiho
Nippon Chikusangaku Kaiho (Japanese Journal of Zootechnical Science) *(Japan)*

Nippon Geka Hokan
Nippon Geka Hokan (Archiv fuer Japanische Chirurgie) *(Japan)*

Nippon Gomu Kyokaishi
Nippon Gomu Kyokaishi (Journal of the Society of Rubber Industry, Japan) *(Japan)*

Nippon Ishikai Zasshi
Nippon Ishikai Zasshi (The Journal of the Japan Medical Association) *(Japan)*

Nippon Kaisui Gakkaishi
Nippon Kaisui Gakkaishi (Bulletin of the Society of Sea Water Science, Japan) *(Japan)*

Nippon Sakumotsu Gakkai Kiji
Nippon Sakumotsu Gakkai Kiji (Proceedings of the Crop Science Society of Japan) *(Japan)*

Nippon Shokuhin Kogyo Gakkaishi
Nippon Shokuhin Kogyo Gakkaishi (Journal of Food Science and Technology) *(Japan)*

Nisshin Seiko Giho
Nisshin Seiko Giho (Technical Report of Nisshin Steel Co., Ltd.) *(Japan)*

Norsk Skogind.
Norsk Skogindustri *(Norway)*

Nucl. Law Bull.
*Nuclear Law Bulletin *(Belgium)*

Nucl. Law Bull., Suppl.
*Nuclear Law Bulletin, Supplement *(Belgium)*

Nukleonika, Supl.
*Nukleonika, Suplement *(Poland)*

N. Z. Dent. J.
New Zealand Dental Journal *(New Zealand)*

N. Z. Sci. Rev.
New Zealand Science Review *(New Zealand)*

Oceanogr. Mag.
Oceanographical Magazine, The *(Japan)*

Ochr. Pr.
Ochrona Pracy *(Poland)*

Odontol. Tidskr.
Odontologisk Tidskrift *(Sweden)*

Oftal'mol. Zh.
Oftal'mologicheskii Zhurnal *(Ukrainian S.S.R.)*

Okayama Daigaku Onsen Kenkyusho Hokoku
Okayama Daigaku Onsen Kenkyusho Hokoku (Papers of the Inst. for Thermal Spring Research, Okayama University) *(Japan)*

Oncol. Radiol.
Oncologia si Radiologia *(Romania)*

Onde Elec., Suppl.
*Onde Electrique, L, Supplement *(France)*

Onsen Kagaku
Onsen Kagaku (Journal of the Balneological Society of Japan) *(Japan)*

Onsen Kagakkaishi
Onsen Kagakkaishi (Journal of the Society of Engineers for Mineral Springs, Japan) *(Japan)*

Opt.-Mekh. Prom.
Optiko-Mekhanicheskaya Promyshlennost *(U.S.S.R.)*

Osaka Daigaku Shigaku Zasshi
Osaka Daigaku Shigaku Zasshi (The Journal of Osaka University Dental Society) *(Japan)*

Osaka Furitsu Kogyo Shoreikan Hokoku
Osaka Furitsu Kogyo Shoreikan Hokoku (Reports of Industrial Research Inst., Osaka Prefecture) *(Japan)*

Oto-Rhino-Laryngol. Clin.
Oto-Rhino-Laryngological Clinic
see Jibiinkoka Rinsho

Paleogeogr., Paleoclimatol., Paleoecol.
Paleogeography, Paleoclimatology, Paleoecology *(Netherlands)*

Paperi Puu-Lehdesta
Paperi ja Puu-Lehdesta *(Finland)*

Pap. Inst. Thermal Spring Res., Okayama Univ.
Papers of the Inst. for Thermal Spring Research, Okayama University
see Okayama Daigaku Onsen Kenkyusho Hokoku

Pediatrics, Suppl.
Pediatrics, Supplement *(U. S.)*

Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Scientiarum Naturalium Universitatis Pekinensis) *(China)*

Petrol Gaze
*Petrol si Gaze *(Romania)*

Photogr. Appl. Sci. Technol.
*Photographic Applications in Science and Technology *(U. S.)*

Phys. Bull. (London)
Physics Bulletin (London) *(England)*

Phys.-Diaet. Ther.
Physikalisch-Diaetetische Therapie *(West Germany)*

Phys. Earth Planet. Interiors
*Physics of the Earth and Planetary Interiors *(Netherlands)*

Pipes Pipelines Int.
Pipes and Pipelines International (formerly International Pipes and Pipelines) *(England)*

Piping Eng.
Piping Engineering, The
see **Haikan Gijutsu**

Plant Breed. Abstr.
*Plant Breeding Abstracts *(England)*

Plant Cell Physiol. (Kyoto)
Plant and Cell Physiology (Kyoto) *(Japan)*

Plant Physiol., Suppl.
*Plant Physiology, Supplement *(U. S.)*

Plastics (London)
*Plastics (London) *(England)*

Poluprov. Prib. Ikh Primen., Sb. Statei
Poluprovodnikovye Pribory i Ikh Primenenie, Sbornik Statei *(U.S.S.R.)*

Pop. Sci. (Peking)
Popular Science (Peking)
see **K'o Hsueh Te Chung**

Poznan. Tow. Przyj. Nauk, Wydz. Lek., Pr. Kom. Farm.
Poznanskie Towarzystwo Przyjaciol Nauk, Wydzial Lekarski, Prace Komisji Farmaceutycznej *(Poland)*

Praxis (Bern)
Praxis (Bern) *(Switzerland)*

Probl. Fiziol. Opt.
Problemy Fiziologicheskoi Optiki *(U.S.S.R.)*

Proc. Amer. Soc. Hort. Sci.
Proceedings of the American Society for Horticultural Science *(U. S.)*

Proc. Astron. Soc. Aust.
Proceedings of the Astronomical Society of Australia *(Australia)*

Proc. Crop Sci. Soc. Jap.
Proceedings of the Crop Science Society of Japan
see **Nippon Sakumotsu Gakkai Kiji**

Proc. Egypt. Acad. Sci.
Proceedings of the Egyptian Academy of Sciences *(Egypt)*

Prochnost Din. Aviats. Dvigatelei
Prochnost i Dinamika Aviatsionnykh Dvigatelei *(U.S.S.R.)*

Proc. Indian Acad. Sci., Sect. B
Proceedings of the Indian Academy of Sciences, Section B *(India)*

Proc. La. Acad. Sci.
*Proceedings of the Louisiana Academy of Sciences, The *(U. S.)*

Proc. Nat. Acad. Sci., India, Sect. A
Proceedings of the National Academy of Sciences, India, Section A *(India)*

Proc. Phys. Soc. (London)
Proceedings of the Physical Society (London) changed to Journal of Physics, A, B, and C *(England)*

Proc. Soc. Water Treat. Exam.
Proceedings of the Society for Water Treatment and Examination *(England)*

Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.)
*Proceedings (Trudy) of the P. N. Lebedev Physics Institute (USSR) (English Translation of Trudy Fizicheskogo Instituta Imeni P. N. Lebedeva, Akademiya Nauk SSSR) *(U. S.)*

Prod. Eng.
Product Engineering *(U. S.)*

Prod. Pharm.
Produits Pharmaceutiques *(France)*

Progr. Anal. Chem.
Progress in Analytical Chemistry *(U. S.)*

Progr. Ind. Microbiol.
Progress in Industrial Microbiology *(U. S.—England)*

Progr. Nucl. Tech. Instrum.
Progress in Nuclear Techniques and Instrumentation *(Netherlands)*

Progr. Solid State Chem.
Progress in Solid State Chemistry *(England)*

Progr. Stiintei
Progresele Stiintei *(Romania)*

Prot. Civ. Secur. Ind.
Protection Civile et Securite Industrielle *(France)*

Protein, Nucl. Acid, Enzyme
Protein, Nucleic Acid, Enzyme
see **Tanpakushitsu Kakusan Koso**

PTB Mitt.
*PTB Mitteilungen. Amts- und Mitteilungsblatt der Physikalisch-Technischen Bundesanstalt *(West Germany)*

Pubbl. Centro Sper. Agr. Forest.
Pubblicazioni del Centro di Sperimentazione Agricola e Forestale *(Italy)*

Queensland Govt. Mining J.
Queensland Government Mining Journal *(Australia)*

Radiat. Res. Rev.
Radiation Research Reviews *(Netherlands)*

Radio (China)
Radio (China)
see **Wu Hsien Tien**

Radiobiol. Biol. Mol.
Radiobiologia si Biologia Moleculara *(Romania)*

Radioprotection
Radioprotection. Bulletin de la Societe Francaise de Radioprotection *(France)*

Rad. Poljopr. Fak. Univ. Sarajevu
Radovi Poljoprivrednog Fakulteta Univerziteta u Sarajevu *(Yugoslavia)*

Rakuno Kagaku No Kenkyu
Rakuno Kagaku No Kenkyu (Japanese Journal of Dairy Science) *(Japan)*

Rast. Nauki
Rastenievʼdni Nauki *(Bulgaria)*

Razved. Okhr. Nedr
Razvedka i Okhrana Nedr *(U.S.S.R.)*

RCN (Reactor Cent. Ned.) Meded.
RCN (Reactor Centrum Nederland) Mededeling *(Netherlands)*

Reactor Fuel-Process. Technol.
*Reactor and Fuel-Processing Technology (A Quarterly Technical Progress Review) (formerly Power Reactor Technology and Reactor Fuel Processing) *(U. S.)*

Rec. Trav. Bot. Neer.
Recueil des Travaux Botaniques Neerlandais *(Netherlands)*

Rend. Semin. Mat. Fis. Milano
Rendiconti del Seminario Matematico e Fisico di Milano *(Italy)*

Rep. Fac. Sci., Shizuoka Univ.
Reports of Faculty of Science, Shizuoka University *(Japan)*

Rep. Fire Res. Inst. Jap.
Report of Fire Research Inst. of Japan
see **Shobo Kenkyusho Hokoku**

Rep. Hokkaido Inst. Public Health
Report of the Hokkaido Inst. of Public Health
see **Hokkaidoritsu Eisei Kenkyusho**

Rep. Ind. Res. Inst., Osaka Prefect.
Reports of Industrial Research Inst., Osaka Prefecture
see **Osaka Furitsu Kogyo Shoreikan Hokoku**

Rep. Nat. Res. Inst. Police Sci.
Reports of the National Research Inst. of Police Science
see **Kagaku Keisatsu Kenkyusho Hokoku**

Rep. Res. Inst. Ind. Safety
Reports of the Research Inst. of Industrial Safety
see **Sangyo Anzen Kenkyusho Hokoku**

Rep. Res. Inst. Sci. Ind., Kyushu Univ.
Reports of the Research Inst. of Science and Industry, Kyushu University
see **Kyushu Daigaku Saisan Kagaku Kenkyusho Hokoku**

Rep. Tokyo-to Lab. Med. Sci.
Report of Tokyo-to Lab. for Medical Sciences
see **Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku**

Rep. Train. Inst. Eng. Teach., Kyoto Univ.
Report of the Training Inst. for Engineering Teachers, Kyoto University
see **Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku**

Res. Electrotech. Lab.
Researches of the Electrotechnical Laboratory
see **Denki Shikenjo Kenkyu Hokoku**

Res. Rep., Nagano Tech. Coll.
Research Reports, Nagano Technical College
see **Nagano Kogyo Koto Senmon Gakko Kiyo**

Rev. Acad. Cienc. Exactas, Fis.-Quim. Natur. Zaragoza
Revista de la Academia de Ciencias Exactas, Fisico-Quimicas y Naturales de Zaragoza *(Spain)*

Rev. Brasil. Quim. (Sao Paulo)
*Revista Brasileria de Quimica *(Brazil)*

Rev. Elec.
Revista Electricidade *(Portugal)*

Rev. Energ. Primaire
Revue Energie Primaire *(Belgium)*

Rev. Fac. Cienc. Agr., Min. Educ., Univ. Nac. Cuyo (Mendoza)
Revista de la Facultad de Ciencias Agrarias, Ministerio de Educacion, Universidad Nacional de Cuyo (Mendoza) *(Argentina)*

Rev. Fr. Elec.
*Revue Francaise de l'Electricite *(France)*

Rev. Gen. Caout. Plast.
Revue Generale du Caoutchouc et des Plastiques *(France)*

Rev. Interamer. Radiol.
Revista Interamericana de Radiologia *(Peru)*

Rev. Int. Oceanogr. Med.
*Revue Internationale d'Oceanographie Medicale *(France)*

Rev. Laryngol., Otol., Rhinol., Suppl.
Revue de Laryngologie, Otologie, Rhinologie, Supplement *(France)*

Rev. Real Acad. Cienc. Exact., Fis. Nat. Madrid
Revista de la Real Academia de Ciencias Exactas, Fisicas y Naturales de Madrid *(Spain)*

Rev. Roum. Sci. Tech., Ser. Mecan. Appl.
Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee *(Romania)*

Rev. Soudure (Brussels)
Revue de la Soudure (Brussels) *(Belgium)*

Rev. Zootch. Med. Vet.
Revista de Zootehnic si Medicina Veterinara *(Romania)*

Rheol. Acta
Rheologica Acta *(West Germany)*

Roczn. Akad. Med. Bialymstoku
Roczniki Akademii Medycznej im. Juliana Marchlewskiego w Bialymstoku *(Poland)*

Roy. Observ. Bull.
Royal Observatory Bulletins *(England)*

Roy. Soc. Health J.
Royal Society of Health Journal *(England)*

Rudarsko-Met. Zbornik, Suppl.
Rudarsko-Metalurski Zbornik, Supplement *(Yugoslavia)*
For English Translation see Mining Met. Quar., Suppl.

Ruimtevaart
Ruimtevaart *(Netherlands)*

RUM, Rev. Universelle Mines
RUM, Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l' Industrie (formerly Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l'Industrie) *(Belgium)*

Russ. Chem. Rev. (Engl. Transl.)
Russian Chemical Reviews (English Translation of Uspekhi Khimii) *(England)*

S. Afr. Mech. Eng.
South African Mechanical Engineer, The *(South Africa)*

Salt Res. Ind. (Bhavnagar, India)
Salt Research and Industry (Bhavnagar, India) *(India)*

Samoletostr. Tekh. Vozdush. Flota
Samoletostroenie i Tekhnika Vozdushnogo Flota *(U.S.S.R.)*

Sangyo Anzen Kenkyusho Hokoku
Sangyo Anzen Kenkyusho Hokoku (Reports of the Research Inst. of Industrial Safety) *(Japan)*

Sb. Geol. Ved, Uzita Geofyz.
Sbornik Geologickych Ved, Uzita Geofyzika *(Czechoslovakia)*

Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove, Suppl.
Sbornik Vedeckych Praci Lekarske Fakulty Karlovy University v Hradci Kralove, Supplementum *(Czechoslovakia)*

Scand. J. Clin. Lab. Invest., Suppl.
Scandinavian Journal of Clinical and Laboratory Investigation, Supplement *(Sweden)*

Schweiz. Arch. Tierheilk.
Schweizer Archiv fuer Tierheilkunde *(Switzerland)*

Schweiz. Muenzbl.
Schweizer Muenzblaetter *(Switzerland)*

Sci. Avenir
Sciences et Avenir *(France)*

Sciences (Paris)
Sciences et l'Enseignement des Sciences (Paris) *(France)*

Sci. Forum
Science Forum *(Canada)*

Sci. Ind. Spatiales
Sciences et Industries Spatiales *(Switzerland)*

Sci. News (Wash., D. C.)
Science News (Washington, D. C.) *(U. S.)*

Sci. Proc. Roy. Dublin Soc., Ser. A
Scientific Proceedings of the Royal Dublin Society, The, Series A (supersedes The Scientific Proceedings of the Royal Dublin Society, New Series) *(Ireland)*

Sci. Rep., Coll. Gen. Educ., Osaka Univ.
Science Report, College of General Education, Osaka University *(Japan)*

Sci. Rep. Niigata Univ., Ser. B
Science Reports of Niigata University, Series B. Physics *(Japan)*

Scr. Met.
Scripta Metallurgica *(U. S.)*

Sekiyu Gakkaishi
Sekiyu Gakkaishi (Journal of the Japan Petroleum Institute) *(Japan)*

Seminars Hematol.
*Seminars in Hematology *(U. S.)*

Seminars Roentgenol.
Seminars in Roentgenology *(U. S.)*

Sen'i Gakkaishi
Sen'i Gakkaishi (Journal of the Society of Fiber Science and Technology, Japan) *(Japan)*

Ser. Haematol.
Series Haematologica (Supplements Scandinavia Journal of Haematology) *(Denmark)*

Sheet Metal Ind.
Sheet Metal Industries *(England)*

Shipping World Shipbuilder
Shipping World and Shipbuilder *(England)*

Shobo Kenkyusho Hokoku
Shobo Kenkyusho Hokoku (Report of Fire Research Inst. of Japan) *(Japan)*

Showa Densen Denran Rebyu
Showa Densen Denran Rebyu (Showa Wire and Cable Review) *(Japan)*

Showa Wire Cable Rev.
Showa Wire and Cable Review
see Showa Densen Denran Rebyu

Sichere Arb.
Sichere Arbeit *(Austria)*

Slaboproudy Obz.
Slaboproudy Obzor *(Czechoslovakia)*

S. Lumberman
Southern Lumberman *(U. S.)*

Soc. Petrol. Eng. J.
Society of Petroleum Engineers Journal, The *(U. S.)*

Soil Crop Sci. Soc. Fla., Proc.
Soil and Crop Science Society of Florida, Proceedings *(U. S.)*

Solid State Technol.
Solid State Technology *(U. S.)*

Soobshch. Shemakhinskoi Astrofiz. Observ., Akad. Nauk Azerb. SSR
*Soobshcheniya Shemakhinskoi Astrofizicheskoi Observatorii, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Sov. Antarct. Exped. Inform. Bull.
Soviet Antarctic Expedition Information Bulletin (English Translation of Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii) *(U. S.)*

Sov. Phys.-Semicond. (Engl. Transl.)
Soviet Physics-Semiconductors (English Translation of Fizika i Tekhnika Poluprovodnikov) *(U. S.)*

Space Biol. Med. (USSR) (Engl. Transl.)
Space Biology and Medicine (USSR) (English Translation of Kosmicheskaya Biologiya i Meditsina) *(U.S.)*

Space Life Sci.
Space Life Sciences *(Netherlands)*

Spectrum (Oxford)
Spectrum (Oxford) *(England)*

Spis. Bulg. Akad. Nauk.
Spisanie na Bulgarskata Akademiya na Naukite *(Bulgaria)*

SRW (Siemens-Reiniger-Werke) Nachr.
SRW (Siemens-Reiniger-Werke) Nachricht *(West Germany)*

Stainless (Tokyo)
Stainless, The (Tokyo)
see Sutenresu

Stain Technol.
Stain Technology *(U. S.)*

Steel Times
Steel Times *(England)*

Strahlenschutz Forsch. Prax.
Strahlenschutz in Forschung und Praxis *(West Germany)*

Strain
Strain *(England)*

Stud. Cercet. Endocrinol.
Studii si Cercetari de Endocrinologie *(Romania)*

Stud. Cercet. Energ. Electroteh.
Studii si Cercetari de Energetica si Electrotehnica *(Romania)*

Stud. Cosmic Ray
Studies of Cosmic Ray
see Uchusen Kenkyu

Sumitomo Kinzoku
Sumitomo Kinzoku (Sumitomo Metals) *(Japan)*

Sumitomo Metals
Sumitomo Metals
see Sumitomo Kinzoku

Sutenresu
Sutenresu (The Stainless) *(Japan)*

Svetsaren Engl.
Svetsaren in English *(Sweden)*

Sv. Lakartidn.
Svenska Lakartidningen *(Sweden)*

Sv. Naturvetensk.
Svensk Naturvetenskap *(Sweden)*

T'ai-wan I Hsueh Hui Tsa Chih

T'ai-wan I Hsueh Hui Tsa Chih (Journal of the Formosan Medical Association) *(China (Taiwan))*

Tanpakushitsu Kakusan Koso
Tanpakushitsu Kakusan Koso (Protein, Nucleic Acid, Enzyme) *(Japan)*

Tech. Dig. (Prague)
Technical Digest (Prague), Statni Nakladetelstvi Technicke Literatury *(Czechoslovakia)*

Tech. Mitt. AEG-Telefunken
*Technische Mitteilungen AEG-Telefunken (a continuation of AEG-Mitteilungen) *(West Germany)*

Technik (Berlin)
Technik (Berlin), Die *(East Germany)*

Technology (Sindri)
Technology (Sindri). Quarterly Bulletin of the Planning and Development Div., Fertilizer Corp. of India Ltd. *(India)*

Technol. Rep. Kyushu Univ.
Technology Reports of the Kyushu University
see *Kyushu Daigaku Kogaku Shuho*

Tech. Note Port Harbour Tech. Res. Inst., Min. Transp., Jap.
Technical Note of Port and Harbour Technical Research Inst., Ministry of Transporation, Japan
see *Kowan Giken Shiryo*

Tech. Petrole
Techniques du Petrole *(France)*

Tech. Rep. ISSP (Inst. Solid State Phys.), Ser. A
Technical Report of ISSP (Inst. for Solid State Physics), Series A *(Japan)*

Tech. Rep. Kumamoto Univ.
Technical Reports of the Kumamoto University
see *Kumamoto Daigaku Kogakubu Kenkyu Hokoku*

Tech. Rep. Nisshin Steel Co., Ltd.
Technical Report of Nisshin Steel Co., Ltd.
see *Nisshin Seiko Giho*

Tec. Ital.
Tecnica Italiana *(Italy)*

Tekhnol. Organ. Proizvod.
Tekhnologiya i Organizatsiya Proizvodstva *(Ukrainian S.S.R.)*

Tekst. Prom.
Tekstil'naya Promyshlennost *(U.S.S.R.)*

Teor. Prakt. Met., Sov. Nar. Khoz. Chelyabinsk. Ekon. Admin. Raiona, Nauch.-Issled. Inst. Met.
Teoriya i Praktika Metallurgii, Sovet Narodnogo Khozyaistva Chelyabinskogo Ekonomicheskogo Administrativnogo Raiona, Nauchno-Issledovatel'skii Institut Metallurgii *(U.S.S.R.)*

Terapia (Milan)
Terapia (Milan) *(Italy)*

Terapia (Turin)
Terapia (Turin) *(Italy)*

Thin Solid Films
Thin Solid Films *(Netherlands)*

Thoraxchir. Vask. Chir.
Thoraxchirurgie und Vaskulaere Chirurgie (formerly Thoraxchirurgie) *(West Germany)*

Tien Shih Chieh
Tien Shih Chieh (Electrical World) *(China)*

Tijdschr. Primaire Energ.
Tijdschrift Primaire Energie
see *Rev. Energ. Primaire*

Tohoku Daigaku Senko Seiren Kenkyusho Iho
Tohoku Daigaku Senko Seiren Kenkyusho Iho (Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University) *(Japan)*

Tokyo Astron. Bull., Ser. II
Tokyo Astronomical Bulletin, Series II *(Japan)*

Tokyo Daigaku Jishin Kenkyusho Iho
Tokyo Daigaku Jishin Kenkyusho Iho (Bulletin of the Earthquake Research Inst., University of Tokyo) *(Japan)*

Tokyo Daigaku Uchu Koku Kenkyusho Hokoku
Tokyo Daigaku Uchu Kenkyusho Hokoku (Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo) *(Japan)*

Tokyo Joshi Ika Daigaku Zasshi
Tokyo Joshi Ika Daigaku Zasshi (Journal of Tokyo Women's Medical College) *(Japan)*

Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku
Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku (Report of Tokyo-to Lab. for Medical Sciences) *(Japan)*

Toninds.-Ztg. Keram. Rundsch.
Tonindustrie-Zeitung und Keramische Rundschau *(West Germany)*

Trans. Amer. Ophthalmol. Soc.
Transactions of the American Ophthalmological Society *(Canada)*

Trans. Indian Ceram. Soc.
Tranactions of the Indian Ceramic Society *(India)*

Trans. Ing.
*Transactions. Ingenioeren *(Denmark)*

Trans. Inst. Metal Finish.
Transactions of the Institute of Metal Finishing *(England)*

Transp. Stroit.
Transportnoe Stroitel'stvo *(U.S.S.R.)*

Trans. Soc. Instrum. Contr. Eng.
Transactions of the Society of Instrument and Control Engineers *(Japan)*

Trans. Soc. Pathol. Jap.
Transactiones Societatis Pathologicae Japonicae
see *Nippon Byori Gakkai Kaishi*

Tr. Arkt. Antarkt. Nauch.-Issled.
Trudy Arkticheskogo i Antarkticheskogo Nauchno-Issledovatel'skogo Instituta *(U.S.S.R.)*

Travaux
Travaux *(France)*

Tr. Gos. Gidrol. Inst.
Trudy Gosudarstvennogo Gidrologicheskogo Instituta *(U.S.S.R.)*

Tr. Gos. Issled. Elektrokeram. Inst.
Trudy Gosudarstvennogo Issledovatel'skogo Elektrokeramicheskogo Instituta *(U.S.S.R.)*

Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal.
Trudy, Gosudarstvennyi Nauchno-Issledovatel'skii i Proektnyi Institut Splavov i Obrabotki Tsvetnykh Metallov *(U.S.S.R.)*

Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial
Trudy Instituta Biologii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial
Trudy Instituta Khimii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

Tr. Inst. Met. Obogashch., Akad. Nauk Kaz. SSR
Trudy Instituta Metallurgii i Obogashcheniya, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Kaz. Nauch.-Issled. Inst. Onkol. Radiol.
Trudy Kazakhskogo Nauchno-Issledovatel'skogo Instituta Onkologii i Radiologii *(Kazakh S.S.R.)*

Tr. Kom. Spektrosk., Akad. Nauk SSSR
Trudy Komissii po Spektroskopii, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Leningrad. Tekhnol. Inst. Tsellyul.-Bum. Prom.
Trudy Leningradskogo Tekhnologicheskogo Instituta Tsellyulozno-Bumazhnoi Promyshlennosti *(U.S.S.R.)*

Tr., Mosk. Aviats. Tekhnol. Inst.
Trudy, Moskovskii Aviatsionnyi Tekhnologicheskii Institut *(U.S.S.R.)*

Tr. Mosk. Vet. Akad.
Trudy Moskovskoi Veterinarnoi Akademii *(U.S.S.R.)*

Tr. Prikl. Bot. Genet. Selek.
Trudy po Prikladnoi Botanike, Genetike i Selektsii *(U.S.S.R.)*

Tr. Sib. Tekhnol. Inst.
Trudy Sibirskogo Tekhnologicheskogo Instituta *(U.S.S.R.)*

Tr. Sov. Antarkt. Eksped.
Trudy Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*

Tr. Teor. Polya
Trudy po Teorii Polya *(U.S.S.R.)*

TRW Space Log
TRW Space Log *(U. S.)*

Tumor Res.
Tumor Research *(Japan)*

Tungsten News
Tungsten News *(U.S.)*

T Z Prakt. Metallbearb.
T Z fuer Praktische Metallbearbeitung *(West Germany)*

Uchusen Kenkyu
Uchusen Kenkyu (Studies of Cosmic Ray) *(Japan)*

Univ. Mich. Med. Cent. J.
University of Michigan Medical Center Journal *(U. S.)*

Upr. Yadern. Energ. Ustanovkami, Sb. Statei
*Upravlenie Yadernymi Energeticheskimi Ustanovkami, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Statei *(U.S.S.R.)*

U. S. Nav. Inst., Proc.
United States Naval Institute, Proceedings *(U. S.)*

Vector (Baltimore)
Vector (Baltimore) *(U. S.)*

Ved. Pr. Vyzk. Ustavu Vet. Lek. Brne
Vedecke Prace Vyzkumneho Ustavu Veterinarniho Lekarstvi v Brne (superseded by Documenta Veterinaria) *(Czechoslovakia)*

Vestn. Cesk. Spolecnosti Zool.
Vestnik Ceskoslovenske Spolecnosti Zoologicke *(Czechoslovakia)*

Vestn. Leningrad. Univ., Ser. Biol.

Vestnik Leningradskogo Universiteta, Seriya Biologii *(U.S.S.R.)*
Vestn. Mosk. Univ., Ser. I, Mat., Mekh.
Vestnik Moskovskogo Universiteta, Seriya I, Matematika, Mekhanika *(U.S.S.R.)*
Vestn. Mosk. Univ., Ser. IV. Geol.
Vestnik Moskovskogo Universiteta, Seriya IV. Geologiya *(U.S.S.R.)*
Vestn. Ustred. Ustavu Geol.
Vestnik Ustredniho Ustavu Geologickeho *(Czechoslovakia)*
Vodosnabzh. Sanit. Tekh.
Vodosnabzhenie i Sanitarnaya Tekhnika *(U.S.S.R.)*
Vojnosanit. Pregl.
Vojnosanitetski Pregled *(Yugoslavia)*
Volt, Elec. Trade Mon.
Volt, Electrical Trade Monthly *(Japan)*
Vop. Eksp. Klin. Radiol., Khar'kov. Inst. Med. Radiol.
Voprosy Eksperimental'noi i Klinicheskoi Radiologii, Khar'kovskii Institut Meditsinskoi Radiologii *(Ukrainian S.S.R.)*
Water Res.
Water Research (supersedes in part Air and Water Pollution) *(England)*
Water Waste Treat.
Water and Waste Treatment *(England)*
Wear
Wear *(Netherlands)*
Weld. Eng.
Welding Engineer *(U. S.)*
Weld. Res. Counc. Bull.
Welding Research Council Bulletin *(U. S.)*
Wiad. Hutn.
Wiadomosci Hutnicze *(Poland)*
Wien. Z. Inn. Med. Grenzgeb.
Wiener Zeitschrift fuer Innere Medizin und ihre Grenzgebiete *(Austria)*
Wiss. Z. Ernst-Moritz-Arndt-Univ. Greifswald, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrfit der Ernst-Moritz-Arndt-Universitaet Greifswald, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*
Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrift der Humboldt-Universitaet zu Berlin, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*
Wonjaryogwon. Yon'gu Nonmun Chip
Wonjaryogwon. Yon'gu Nonmun Chip *see J. Nucl. Sci. (Seoul)*
World Meteorol. Organ. Bull.
*World Meteorological Organization Bulletin *(Switzerland)*
World Mining
World Mining *(U. S.)*
Wu Hsien Tien
Wu Hsien Tien (Radio) *(China)*
Yadern. Priborostr., Nauch.-Tekh. Sb.
Yadernoe Priborostroenie, Nauchno-Tekhnicheskii Sbornik *(U.S.S.R.)*
Yakugaku Kenkyu
Yakugaku Kenkyu (Japanese Journal of Pharmacy and Chemistry) *(Japan)*
Yuan Tzu Neng
Yuan Tzu Neng (Atomic Energy) *(China)*
Zap. Leningrad. Gorn. Inst.
Zapiski Leningradskogo Gornogo Instituta *(U.S.S.R.)*
Zem. Beton
Zement und Beton *(Austria)*
Zemlya Vselennaya
Zemlya i Vselennaya *(U.S.S.R.)*
Zentralbl. Neurochir.
Zentralblatt fuer Neurochirurgie *(East Germany)*
Z. Ernaehrungswiss., Suppl.
Zeitschrift fuer Ernaehrungswissenschaft, Supplementa *(West Germany)*
Zesz. Nauk. Politech. Slaska, Energ.
Zeszyty Naukowe Politechnika Slaska, Energetyka *(Poland)*
Zh. Org. Khim.
*Zhurnal Organicheskoi Khimii *(U.S.S.R.)*
Z. Immunitaetsforsch., Allergie Klin. Immunol.
Zeitschrift fuer Immunitaetsforschung, Allergie und Klinische Immunologie *(West Germany)*
Z. Kinderheilk.
Zeitschrift fuer Kinderheilkunde *(West Germany)*
Z. Math. Phys.
Zeitschrift fuer Mathematik und Physik *(East Germany)*
Z. Mikrosk.-Anat. Forsch.
Zeitschrift fuer Mikroskopisch-Anatomische Forschung (Abt. 2 of Jahrbuch fuer Morphologie und Mikroskopische Anatomie) *(East Germany)*
Zolnierz Pol.
Zolnierz Polski *(Poland)*
Zoologica (Seoul)
Zoologica (Seoul) *(South Korea)*
Zool. Zh.
Zoologicheskii Zhurnal *(U.S.S.R.)*
Z. Phys. Chem. B
Zeitschrift fuer Physikalische Chemie. Abt. B *(Germany)*
Z. Psychol. Physiol. Sinnesorg.
Zeitschrift fuer Psychologie und Physiologie der Sinnesorgane *(East Germany)*
Z. Sinnesphysiol.
Zeitschrift fuer Sinnesphysiologie *(East Germany)*
Z. Tech. Ueberwach.
Zeitschrift Technische Ueberwachung *(Austria)*
Z. Urol. Nephrol.
Zeitschrift fuer Urologie und Nephrologie *(East Germany)*

☆U. S. GOVERNMENT PRINTING OFFICE: 1968— 345-444/4

NOTICE

A title page for Volume 22, Numbers 13–18, is included at the back of this issue for use in binding those issues.

CORRECTIONS

NSA Vol. 21, No. 10, Abst. No. 15945, lines 5 and 6 should read: Infrared spectroscopy has been found to be a valuable tool in studying radiation-induced graft copolymerization reactions. Gamma radiation when absorbed

NSA Vol. 21, No. 18, Abst. No. 34116, lines 3 and 4 should read: R. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [1966]. Contract AT(30-1)-3017. 124p.

NSA Vol. 22, No. 1, Abst. No. 1024, line 3 should read: Pak, Byong-So (Uppsala Univ.) Ark. Geofys., 5: 283-304(1967).

NSA Vol. 22, No. 5, Abst. No. 8727, line 1 should read: (ORNL-4170, pp 8-11) DEFORMATION AND AN-

NSA Vol. 22, No. 6, Abst. No. 11866, line 3 should read: Filed Aug. 10, 1963.

NSA Vol. 22, No. 6, Abst. No. 12153, line 5 should read: Rapid shutdown of a nuclear reactor is achieved by pouring neu-

NSA Vol. 22, No. 10, Abst. No. 20401, line 2 should read: E.; Froelich, R. (to Canadian Patents and Development Ltd.).